SCIENTIFIC AMERICAN

No. SUPPLEMENT 111

Scientific American Supplement, Vol. V, No. 111. Scientific American, established 1845. | NEW YORK, FEBRUARY 16, 1878. | Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

THE MODERN TELESCOPE.*

By J. NORMAN LOCKYER.

II.

WHETHER the telescope be of the first order or last order of excellence, its light-grasping powers will be practically the same; there is therefore a great distinction to be drawn between the illuminating and defining power. The former, as we have seen, depends upon size (and subsidiarily upon polish); the latter depends upon the accuracy of the curvature of the surface.

If the defining power be not good, even if the air be perfect, each increase of the magnifying power so brings out the defects of the image that at last no details at all are visible; all outlines are blurred or stellar character is lost. Even with the best telescopes the power should not be strained.

The testing of a glass therefore refers to two different qualities which it should possess. Its quality as to material and the fineness of its polish should be such that the maximum of light shall be transmitted. Its quality as to the curves should be such that the rays passing through every part of its area shall converge absolutely to the same point, with a chromatic aberration not absolutely *nil*, but sufficient to surround objects with a faint violet light. With the reflector we have to consider the brilliancy of the surface and the perfection of curvature.

In close double stars, therefore, or in the more minute markings of the sun, moon, or planets, we have tests of its defining power; and if this is equally good in the instruments examined, the revelations of telescopes as they increase in power are of the most amazing kind.

A 3¼-inch suffices to show Saturn with all the detail shown in Fig. 5, while Fig. 6 shows us the further minute structure of the rings which comes out when the planet is observed with an object-glass with an aperture of 26 inches.

In the matter of double stars, a telescope of 2 inches aperture, with powers varying from 60 to 100, should show the following stars double:—

Polaris.	ρ Herculis.
α Piscium.	ζ Ursæ Majoris.
μ Draconis.	α Geminorum.
γ Arietis.	γ Leonis.
	ξ Cassiopeæ.

A 4-inch aperture, powers 80–120, reveals the duplicity of—

β Orionis.	ζ Ursæ Majoris.
ε Hydræ.	γ Ceti.
ε Boötis.	δ Geminorum.
Leonis.	σ Cassiopeæ.
α Lyræ.	ε Draconis.

A 6-inch, powers 240–300—

ε Arietis.	κ Geminorum.
32 Orionis.	ε Equulei.
λ Ophiuchi.	ζ Herculis.
20 Draconis.	ζ Boötis.

An 8-inch—

δ Cygni.	19 Draconis.
γ^2 Andromedæ.	μ^2 Herculis.
Sirius.	μ^3 Boötis.

The "spurious disk," which a fixed star presents, as seen in the telescope, is an effect which results from the passage of the light through the circular object-glass, or its reflection from a circular mirror; and it is this appearance which necessitates the use of the largest apertures in the observation of close double stars, as the size of the star's disk varies, roughly speaking, in the inverse ratio of the aperture.

In our climate, which is not so bad as some would make it, a 6 to an 8 inch glass is doubtless the size which will be found the most constantly useful; larger apertures being frequently not only useless, but hurtful. Still, 4 or 3¾ inches are apertures by all means to be encouraged; and by object-glasses of these sizes, made, of course, by the *best* makers, views of the sun, moon, planets, and double stars may be obtained, sufficiently striking to set many seriously to work as amateur observers, and with a prospect of securing good, useful results.

Observations should always be commenced with the lowest power, gradually increasing it until the limit of the aperture, or of the atmospheric condition at the time, is reached. The former may be taken as equal to the number of hundredths of inches which the diameter of the object-glass contains. Thus, a 3¾-inch object-glass, if really good, should bear a power of 375 on double stars where light is no object; the planets, the moon, etc., will be best observed with a much lower power.

Care should be taken that the object-glass is properly adjusted. And we may here repeat that this may be done by observing the image of a large star out of focus. If the light be not equally distributed over the image, or the diffraction rings are not circular, the screws of the cell should be carefully loosened, and that part of the cell toward which the rings are thrown very gently tapped with wood, to force it toward the eye-piece; or the same purpose may be effected by means of the set-screws always present on large telescopes,

* Continued from SUPPLEMENT No. 107, page 1698.

until perfectly equal illumination is arrived at. This, however, should only be done in extreme cases; it is here especially desirable that we should let well alone. In the case of mirrors, instructions for adjustment are generally given by the maker.

The convenient altitude at which Orion culminates in these latitudes renders it particularly eligible for observation; and during the first months of the year our readers who would

FIG. 5.—Saturn and his moons (general view with a 3¼ inch object-glass).

test their telescopes will do well not to lose the opportunity of trying the progressively difficult tests, both of illuminating and separating power, afforded by its various double and multiple systems, which are collected together in such a circumscribed region of the heavens that no extensive movement of their instruments—an important point in extreme cases—will be necessary.

Beginning with δ, the upper of the three stars which form the belt, the two components will be visible in almost any instrument which may be used for seeing them, being of the second and seventh magnitudes, and well separated. The companion to β, though of the same magnitude as that to δ, is much more difficult to observe, in consequence of its proximity to its bright primary, a first magnitude star. Quaint old Kitchener, in his work on telescopes, mentions that the companion to Rigel has been seen with an object-glass of 2¼-inch aperture; it should be seen, at all events, with a 3-inch. The bottom star in the belt is a capital test both of the dividing and space-penetrating power, as the two bright stars of the second and sixth magnitudes, of which the close double is composed, are exactly 2¼" apart, while there is a companion to one of these components of the twelfth magnitude about ¾" distant. The small star below, which the late Admiral Smyth, in his charming book, "The Celestial Cycle," mentions as a test for his object-glass of 5·9 inches in diameter, is now plainly to be seen in a 3¼. The colors of this pair have been variously stated.

That either our modern opticians contrive to admit more light by means of a superior polish imparted to the surfaces of the object-glass, or that the stars themselves are becoming brighter, is again evidenced by the point of light, preceding one of the brightest stars in the system composing ζ. This little twinkler is now always to be seen in a 3¼-inch, while the same authority we have before quoted—Admiral Smyth—speaks of it as being of very difficult vision in his instrument of much larger dimensions. In this very beautiful compound system there are no less than seven principal stars; and there are several other faint ones in the field. The upper very faint companion of λ is a delicate test for a 3¼-inch, which aperture, however, will readily divide the closer double of the principal stars which are about 5" apart.

These objects, with the exception of ζ, have been given more to test the space-penetrating than the dividing power; the telescope's action on 52 Orionis will at once decide this latter quality. This star, just visible to the naked eye on a fine night, to the right of a line joining α and δ, is a very close double. The components of the sixth magnitude are separated by less than two seconds of arc, and the glass which shows a *good wide black division* between them, free from all stray light, the spurious disk being perfectly round, *and not too large*, is by no means to be despised.

Then, again, we have a capital test object in the great nebula to which reference has already been made.

The star to which we wish to call especial attention is situated (see Fig. 4) opposite the bottom of the "fauces," the name given to the indentation which gives rise to the appearance of the "fish's mouth." This object, which has been designated the "trapezium," from the figure formed by its principal components, consists, in fact, of six stars, the fifth and sixth (γ' and σ') being excessively faint. Our previous remark relative to the increased brightness of the stars applies here with great force; for the fifth escaped the gaze of the elder Herschel, armed with his powerful instruments, and was not discovered until 1826, by Struve, who, in his turn, missed the sixth star, which, as well as the fifth, has been seen in modern achromatics of such small size as to make all comparison with the giant telescopes used by these astronomers ridiculous.

Sir John Herschel has rated γ' and σ' of the twelfth and fourteenth magnitudes—the latter requires a high power to observe it, by reason of its proximity to α. Both these stars have been seen in an ordinary 5-foot achromatic, by Cooke, of 3¾ inches aperture, a fact speaking volumes for the perfection of surface and polish attained by our modern opticians.

Let us now try to form some idea of the perfection of the modern object-glass. We will take a telescope of eight inches aperture and ten feet focal length. Suppose we observe a close double star, such as ξ Ursæ; then the images of these two stars will be brought to a focus side by side, as we have previously explained, and the distance by which they will be separated will be dependent on the focal length of the object-glass.

FIG. 6.—DETAILS OF THE RING OF SATURN OBSERVED BY TROUVELOT WITH THE 26-INCH WASHINGTON REFRACTOR.

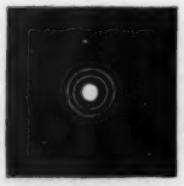


FIG. 7.—Appearance of diffraction rings round a star when the object-glass is properly adjusted.

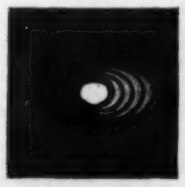


FIG. 8.—Appearance of same object when object-glass is out of adjustment.

If we take a telescope ten feet long and look at two stars 1° apart, the angle will be 1°, and at ten feet off the distance between the two images will be something like $2\frac{1}{6}$ inches, and therefore, if the angle be a second, the lines will be the $\frac{1}{3600}$th part of that, or about $\frac{1}{13000}$th part of an inch apart, so that in order to be able to see the double star ξ Ursæ, which is a 1" star, by means of an eight-inch object-glass, all the surfaces, the 50 square inches of surface of both sides of the crown and both sides of the flint glass, must be so absolutely true and accurate that, after the light is seized by the object-glass, we must have those two stars absolutely perfectly distinct at the distance of the seventeen-hundredth part of an inch, and in order to see stars ½" apart, their images must be distinct at one-half of this distance or at $\frac{1}{34000}$th part of an inch from each other.—*Nature*.

A REMARKABLE MAN.

IF you lock up the idlest and most stupid tramp in a dungeon, he will work night and day to get out. He will be more than industrious. Often he will show himself exceedingly smart in deceiving his keepers, in filing off his chains, in unscrewing locks, and tunneling through stone walls; clever enough, had his work been rightly and steadily applied, to have got himself a medal at the Centennial Exhibition, and perhaps a large fortune. And so of any young man who is good, honest, industrious; only lock him up in the dungeon of deep poverty, and, in order to get out, he will show the most wonderful skill and ingenuity. Let a story be told to illustrate this:

Once upon a time there lived in Fall River, Massachusetts, a young man named Alvan. He worked hard as an engraver of designs for calico prints, and was one of the quietest and most childlike of persons. There was a certain Manlius Sargeant who was universally known in those days as a

public speaker; and Alvan, who had had no instruction whatever in painting, and who had only seen Sargeant upon the streets and on the platform, painted a picture of him. It was said to be so good that he went to Boston, rented a small room, hung out his sign, and waited for Boston to crowd to him to have its many portraits painted. Waiting was for a long time all the work he had to do, and of all work it is the hardest. Many a weary day and sleepless night did he wonder where the money was to come from upon which to live. At last, in sheer desperation, he one day took his picture of Mr. Sargeant and went on the streets to find a buyer. Seeing some persons in a place of business, he went in and held up the likeness. It was instantly recognized and declared to be very good, so good that a Dr. Bemis, who was one of the gentlemen, sat to Alvan himself and brought all his acquaintances to do so, too, becoming his warm friend.

The young artist had plenty of pictures to paint henceforth, but his way of doing it was peculiar. He had a mirror so fixed as to throw the face of the sitter upon the bottom of a desk at which he sat, the bottom being covered with canvas, upon which he traced the outlines. Next he would dot the drawing all over with numbers, each of which designated the exact shade of color in the sitter's face to be placed there. It was a mechanical process, but the portraits were truth itself. By way of exercise, he made an air-gun and shot at marks upon a wall. From that he made himself the best marksman with a rifle in Boston. Observing that it insured the accuracy of the ball to do it, he made a very short tube which he fitted on the end of the rifle, in driving the cartridge down, taking the tube off before firing. Still more ingenious were the telescopic sights which he made for his rifle. That was the origin of the work which has made him famous. From the smallest experiments when about forty years old, he began to manufacture telescopes. In 1857 an achromatic telescope was imported for the use of Harvard College, and he immediately made another which proved to be far superior. This was intended for a college in Mississippi, but the war breaking out, it went to the Chicago Observatory.

I spent a delightful day yesterday at his factory in Cambridge, near Boston. Upon the grounds near the houses in which he and his sons live is a wooden building twenty-five by forty-five feet in size and two stories high, with a basement. Here is the engine and the simple machinery by means of which the best telescopes in the world are now made. It is Alvan Clark of whom I am speaking. His two sons are associated with him, there being a mutual affection among them as well as a simplicity of manners which charmed me greatly.

"I happened," said Mr. Alvan Clark, the youngest son of the old gentleman, who is now seventy-two years of age, "to be looking through one of our largest telescopes at Sirius one night in 1862. You know that Sirius is the brightest star in the heavens. It is one hundred and twenty-three billions of miles away, and is four hundred times the size and power of our sun. M. Bessel had said that there must be something to make Sirius vary from its line of motion, and that night, sure enough, I saw the planet of its system which did it."

Young Mr. Clark was whittling a stick when he told me, and did not think it was anything very remarkable; but the French Institute awarded him a medal for it, and it made him and his father's glasses famous forever. It was with one of these telescopes that Asaph Hall lately discovered the two moons of Mars. Queer moons they are, not more than five or ten miles in diameter, and revolving about Mars every seven hours. It took but a small pebble, however, to slay Goliath, and it is not impossible that those little brick-bats, so to speak, of moons may kill the grand nebular hypothesis, which has been a sort of religion of astronomers for so long. The moons move altogether too rapidly to be accounted for upon that theory, Mr. Clark told me.

In the factory I saw the telescope being made for Princeton College, which is to cost $4,000, and another for the Portuguese Government, to cost $6,000. Mr. Clark is also building another, which is to be a present from Mr. McCormick, of Chicago, to a Virginia college, which is to cost $25,000. Mr. James Lick, of California, applied to them to make the largest telescope possible for him, but did not persist when he learned that it would cost $180,000. The son who discovered the planet of Sirius told me that he hopes to make one which will have an object glass some thirty-six inches in diameter, which will be by far the very largest ever made, and who can tell what it may not reveal?

In the yard are great tubes pointed to the heavens in which glasses are tested, and there is a tunnel two hundred and thirty feet long, one foot in diameter, for the same purpose—a candle at the end looking exactly like a star. Old Mr. Clark has so formed the habit of work that he can never cease working as long as he lives. He and his sons were grinding away in their shirt-sleeves at glasses when I arrived. Red paint is the only thing used to grind with, and after a month of grinding with the hand, the glass gaining in power every day, not a tenth of a grain will have been ground off. It took a steady year at it for the glasses by which the moons of Mars were discovered, and their power can be understood when it is remembered that a microscopic photograph illegible to the eye was easily read through them at a distance of three hundred feet. Not work only—the utmost patience and care is required. A lens will be made untrue, and so as to distort a star seen through it, by its own weight, by the warmth of the hand touching it, or of a breath—by the animal heat, even, of a person standing near. As Mr. Clark told me of this I wondered if, in like manner, it is not from some perhaps unconscious fault in us that celestial things seem to us so unlike what they really are.

I have not space to tell of the ingenious electric arrangement by which the foot of a burglar in the building at night, or the heat of a kindling fire, will arouse the sleepers in the homes near by. Nor can I speak as freely as I would like of the white-haired, bright-eyed old gentleman who is, his old friends tell me, as childlike as he was sixty years ago. Upon the whole, although Mr. Clark's telescopes are the best in the world, I was less interested in them than in the processes by which he was made what he is. He is vastly more remarkable himself than any telescope he will ever make.—WILLIAM M. BAKER, *in Sunday Afternoon.*

MAGNETIZATION OF TUBES OF STEEL.

By J. M. GAUGAIN.

THE variations of magnetism produced under the influence of heat in a solid bar of steel do not differ from those produced under the same influence in a system composed of a tube and a nucleus. Both appear to depend on the inverse magnetism developed by the mutual reaction of the concentric layers, whether of the bar or of the system.

ON A NEW ARRANGEMENT FOR DISTINGUISHING THE AXES OF DOUBLY REFRACTING SUBSTANCES.*

By H. C. SORBY, F.R.S., President R.M.S.

IN studying with the microscope thin portions of doubly refracting crystals, seen detached or in sections of rocks, very little attention has hitherto been paid to the direction of the positive and negative axes, although a knowledge of this may afford most valuable information, as I have already shown in some of my former published papers. I must say that I am not at all surprised, since, though fully impressed with its importance, I have often neglected to make use of the form of apparatus hitherto employed, on account of the practical difficulties of the method and the uncertainty of the results. I have for a long time been anxious to devise some such modification of the necessary apparatus as would enable me with ease and certainty to ascertain which is the positive and which is the negative axis of any crystal, and have at length contrived a plan which appears to me in every respect satisfactory.

In order that the method may be more clearly understood, it will be desirable to briefly describe a few well-known facts: If a thin section of a doubly refracting crystal cut obliquely or parallel to an optic axis be examined with polarized light and a crossed analyzer, it will in certain positions give colors by interference, the exact tints of which depend upon the thickness of the action and the intensity of its double refraction. If another section thus giving the same tint of the same order be placed over the other, the tints due to the combination depend on the manner in which they are placed in relation to one another. If their positive axes are parallel, the effect is the same as if the thickness were double, and the tints are raised; whereas, if the positive axes are at right angles, and thus the positive axis of one parallel to the negative axis of the other, the doubly refracting power is, as it were, neutralized, and with crossed Nicols the field remains dark and the crystal looks black. If the crystal under examination vary somewhat in thickness, so as to give by itself various colors, then only those parts which give the right tint appear black when the two plates are properly combined. In other parts the tints are raised or lowered, as the case may be, and it may be so difficult to distinguish between these higher and lower orders of colors that the determination may be very doubtful.

In applying this method to the microscope, thin flat plates of selenite of various thickness have usually been employed, either under the object on the stage or under the analyzer over the eye-piece. The chief practical difficulty was to select a plate of selenite of such a thickness that its tint with polarized light was so nearly the same as that of the crystal under examination that there could be no kind of doubt when the tints were raised and when depressed. If the apparatus contains many plates of selenite, much time is consumed in finding the right one; and if it contains but few, none may give such a decided result that the direction of the positive and negative axes can be seen at once, and no consideration be required.

Now the method which I have lately adopted combines all the advantages of a very large number of plates of selenite with the practical convenience of a single plate, and also enables us at once to determine the true order of the tint given by any crystal under examination. I have a wedge-shaped plate of quartz, cut parallel to the principal axis, 1¼ inch long and ½ inch wide. At its thickest end it is $\frac{1}{30}$th of an inch thick, and thins off to the sharpest possible edge. This is fixed on a glass plate so as to leave a space of glass $\frac{5}{16}$ths of an inch long by ½ inch broad beyond this thin end of the quartz. The combined plates are fixed in a brass frame, like that of a micrometer, which slides into the eye-piece. On using polarized light with a crossed analyzer over the eye-piece, and arranging the plate so that the part with only glass is in front, we see the object in its normal state, and the rest of the field black, and on pushing forward the quartz wedge we see the field of the microscope crossed with colored bands, gradually rising from the bluish white of the first order, through all the brighter orders of colors to the faint reds and greens, and upward to what cannot be distinguished by the unaided eye from white light. If some crystal giving any tint be on the stage of the microscope, we can usually see at once whether the tints are raised or depressed, by the manner in which it alters the color of the bands; and by pushing the quartz wedge backward or forward there may be no difficulty in finding the exact place where the plate of quartz so exactly neutralizes the action of the crystal that it appears black. If this does not occur in any place, and, on the contrary, the tints appear to be raised, the eye-piece and the plate must be rotated through an angle of 90°, and the requisite place can then be easily found. The plate of quartz being so cut that its longer axis is parallel to the principal axis of the crystal, we know that the longer axis is positive, and thus also at once know which is the positive and which the negative axis of the crystal under examination. We can also at once see what is the true order of color which it gives, since we can readily count it up from the bands due to the quartz alone, seen crossing the field of the microscope. We are also by no means limited to visible tints. The crystal may have such a powerful double refraction or be so thick as to give apparently white light, and yet by using the thicker end of the quartz wedge the tints may be reduced down to those easily distinguished.

It will thus be seen that by using this simple arrangement we secure all the advantages of a most unmanageably large number of plates of selenite, and can make all the necessary observations with ease and expedition. It now remains in conclusion to point out its practical use.

In examining thin sections of rocks or loose material, crystals of elongated prismatic form are very often seen. The optical axes may or may not be parallel to the geometrical axis, and this is a character of considerable importance. Now, by means of the apparatus I have just described, we can at once ascertain whether it is the positive or negative axis which is more or less parallel to the geometrical axis. This might serve to easily distinguish two minerals. One might have its negative axis parallel to the prism, and thus might appear black when the quartz plate was parallel to it; whereas in the case of the other mineral, the positive axis might be parallel to the prism, and it might appear black when the quartz plate was at right angles to the axis of the prism. Of course in making these observations we must be careful to arrange so that the plane of polarization of the light is at 45° to one of the axes of the crystal, and the axis of the quartz plate either parallel or at right angles to that axis, as the case may require.

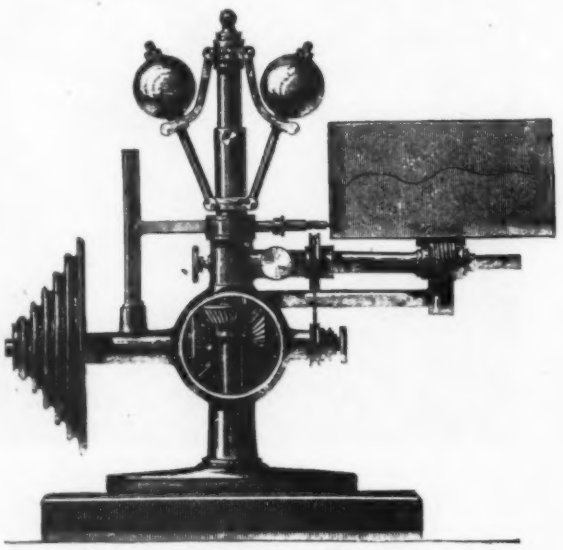
Though I have hitherto specially alluded to crystals, the use of this method is by no means confined to true minerals. It may be employed with equal advantage in studying shells and other organic bodies which possess double refraction. We can thus at once see that in the shells of Pinna the negative axis is parallel to the axis of the prisms, as in the case of true crystals of calcite deposited on the wall of a vein or other surface of deposition, and in the case of some other shells may see that the negative axis of the aragonite is also perpendicular to the surface of their growth, as it also is when that mineral is deposited quite independent of any organic matter.

*Read before the Royal Microscopical Society, October 3, 1877.

VELOCITY METER, OR SELF-REGISTERING TACHOMETER.

THE inventor, R. Proell, Ph. D., of Dresden, Saxony, in describing his apparatus in the "*Deutsche Industrie Zeitung*," states that the results obtained by theoretically calculating the changing velocities of moving masses are practically considered to a certain extent faulty, and that therefore an apparatus which graphically records them is very desirable.

The apparatus shown in the illustration is adapted for the tracing of diagrams of the varying velocities in steam engines and hydraulic motors.



INSTRUMENT FOR REGISTERING VELOCITIES.

In the cast iron frame, provided with a broad foot-plate, of the apparatus is placed the vertical spindle of the tachometer, which is made to revolve by means of a cone pulley and round belt. The lower sleeve of the tachometer carries a pencil, which by means of a spiral spring is gently pressed against the circumference of a rotating drum, marking on the paper the then height of the sleeve. On the opposite side the sleeve is provided with an arm which moves up and down according to the motion of the sleeve, on a vertical standard on which is a scale. As seen, the drum is made to revolve at a speed proportionate to the spindle motion, so that the abscissas of the diagram are proportional to the distances traveled. The ordinates show the velocity for any moment of time, and correspond with the heights marked on the scale.

The spindle is hollow and slit the whole length of the lift; through the slit and the under part of the sleeve is placed a set screw supporting a spiral spring 7·87 in. long. This spring is only adjusted just before the apparatus is put into gear.

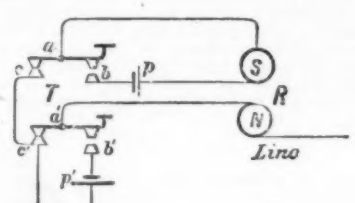
In taking a diagram the band is placed on the shaft of the fly-wheel of the machine to be tested, and belted on to the cone pulley, the drum belting being unattached. The apparatus is then screwed down in position; all being ready, the drum connection is belted on, and the pencil performs its work of tracing the diagram curve. A change in the speed ordinates of from ·03937 in. to ·05905 in. corresponds to a change of velocity of 1%. Various forms of this tachometer are built to suit particular classes of machines to be tested.

SIMULTANEOUS TRANSMISSION IN OPPOSITE DIRECTIONS.

By M. GIOVANNI MARINI, of the Italian Telegraphic Administration.

THE system of double transmission that I am about to describe is based upon the following principles: A relay with two bobbins is fixed to a permanent magnet in such a way that the armature acts by repulsion, and not by attraction. The wire of one of the bobbins is distinct from the wire of the other bobbin, and the two wires thus form two distinct circuits—the one a local circuit, the other a line circuit. The soft iron cores of these two bobbins of the relay are fixed, the one to the north pole and the other to the south pole of a permanent magnet. The transmitting key is of the ordinary Morse form, very slightly modified; to the front part of it two contacts insulated from one another are added, which serve for the two circuits above mentioned. These contacts should be so adjusted that by the movement of the key they should make or break contact exactly at the same moment.

The figure represents the arrangement of this system of double transmission. R represents the relay, N the bobbin with the north pole, S the bobbin with the south pole, T the double key, a and a' the two levers of the key, formed of little flat springs, to which springs the two outer ends of the wires of the bobbins are connected; c and c' are two metallic contacts fixed at the extremities of the levers and in connection with the earth. In the normal position of this double key the levers rest on these contacts, and are thus in



connection with the earth; b and b are two little metallic plates connected to the positive poles of two batteries—the local battery p and the line battery p'. The connections being thus arranged, the following results are obtained:

It is first of all necessary that the strength of the local battery, which sends a current through the south pole bobbin, be so regulated that it may transmit a current exactly equal in power to the one sent out by the line battery through the wire of the other bobbin and out to line to the corresponding instrument at the further station. This equality can be arrived at by observing the deviations given by a good galvanometer, which can be switched either into the line or the local circuit—the battery of the latter being varied, so that the deflections in both cases are the same. When the batteries are in good condition this equilibrium may be maintained for several days unless accidental circumstances interfere.

For a line of a given resistance the relation between the local and line batteries is in the proportion of about 1 to 8. If, now, the key at one station be depressed, the levers a a' are put simultaneously in communication with the contacts b b' and at the same instant the communication of the levers c c' with the earth is interrupted. The current of the local battery p traverses the south pole bobbins to get to earth, and produces in the soft iron core a contrary magnetism to that which is given it by the permanent magnet; that is to say, the current tends to diminish the attractive force of the core for the armature; but, at the same time, the current of the line battery p' traverses the north pole bobbin and out to line, and increases the attractive power of the core of that bobbin; for at the transmitting station this current produces in the soft iron core a magnetism equal to that which the local battery takes away, consequently the armature remains attracted against the poles.

At the other station, the arrival current entering by the outer extremity of the wire of the north pole bobbin goes to earth through the lever a' and the contact c', and produces in the soft iron core a magnetism contrary to that which is given it by the permanent magnet; the attractive force on the armature being thus diminished, the armature rises off the poles under the influence of an antagonistic spring. Immediately on the cessation of the current the core regains its magnetism, and the armature is again attracted.

Finally, if the keys at both stations are simultaneously depressed, the currents going out to line being equal and contrary, annul one another, and thus the north pole bobbins of the two relays are not influenced by the currents. The south pole cores, then, being both under the influence of the local batteries, have their magnetic powers diminished, and the armatures at both stations consequently rise.

If in this last position one station allows his key to rise, the current from that station ceases to be emitted by him; but the connection of the line wire to earth is not interrupted, and the armature, though no longer under the influence of the local current, but under the influence of the current from the other station, which current is no longer nullified, continues to remain detached from the poles of the magnet. But at the moment when there are no longer simultaneous currents on the line, the battery of the station which continues to keep his key depressed itself ceases to influence its own electro-magnet, and the armature at that station consequently rises.

Thus, then, the armature acts when the current arrives on the relay, or when the local battery is in action; but in these two cases, in order to detach the armature of the electro-magnet, it is sufficient simply to adjust it so that the strength of the arrival current is sufficient to diminish a little the magnetism imparted by the permanent magnet, and the armature then detaches itself from the cores by the influence of the antagonistic spring, and never by the action of the arrival or the local current.

When, on the contrary, the armature is attracted, this attraction always takes place in virtue of the same constant force of the magnet, which at the moment when the arrival current ceases on the relay, or on the line, restores magnetic power to the cores as much when the key of the station by which they are acted on is in its normal condition as when it is depressed. Under this condition the armature is always attracted by a permanent magnetic force of equal strength without undergoing in its movements any kind of change which could prevent the correct reception of the signals. In the laboratory experiments this result can be obtained by the same form of key and with the same connections with an ordinary relay, or Morse ink-writer of sufficient resistance, provided the two bobbins are separate, so that the connections can be made in the manner which has been indicated.

But such is not the case on a line where, the armature of an ordinary relay being attracted irrespectively by the arrival and the local current, which are never equal (that of arrival being from the leakage on the line always less than the local current, which, as we have before said, is equal in strength to the departure current), would thus be affected either by the greater or by the less force, being thus able to remain continuously attracted if the spring is adjusted for the smaller current, or not being attracted at all if adjusted for the greater current.

In all these cases the movements of the armature would be very irregular, whence would result confused, broken, or weak signals.

It is for this reason that I have proposed for this system of transmission a relay with a polarized electro-magnet.—*Journal Telegraphique.*

ELECTRIC CURRENTS OF HIGH TENSION.

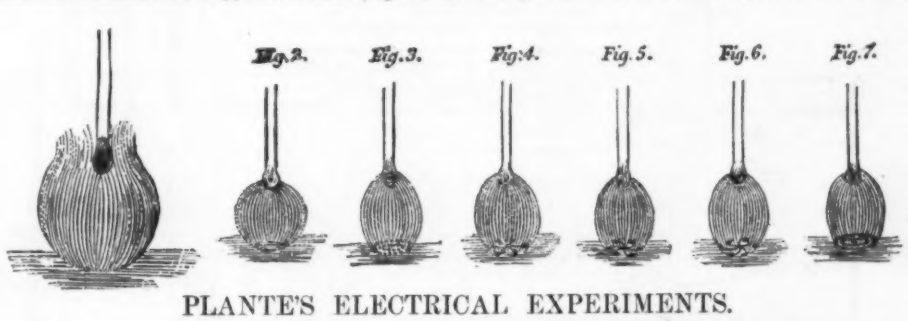
By M. GASTON PLANTE.

Comptes Rendus de l'Academie des Sciences.

FOR the purpose of studying the effects produced upon distilled water, I have augmented the tension of the current employed, by uniting 20 secondary batteries, each composed of 40 couples, making a total of 800 secondary couples, and giving a current about equal to that from 1200 Bunsen's elements.

When this current is caused to act upon distilled water, the effects observed by Mr. Grove with 500 of his nitric acid cells are reproduced, but much intensified. The positive electrode being previously plunged into distilled water, on bringing the negative platinum wire to the surface of the water and immediately removing it, a nearly spherical yellow flame is obtained, about two centimeters in diameter (Fig. 1). The platinum wire of two millimeters diameter quickly fuses and remains for some instants in a state of fusion to a height of 14 or 15 millimeters above the surface of the liquid. The flame is formed by incandescent rarefied air, by the vapor of the metal forming the electrode, and by the elements of the decomposed water vapor. Spectrum analysis clearly declares the presence, above all, of hydrogen.

If to avoid the fusion of the metal the intensity of the current is diminished by interposing a column of water in the circuit, the spark takes the form of a compact little globe of fire, from 8 to 10 mms. diameter (Fig. 2). Drawing away, slightly, the electrode, this globe takes an ovoid form; luminous blue points, continually varying in number and arranged in consecutive circles, appear on the surface of the water (Fig. 3). Rays of the same color soon start from the center and join these points (Fig. 4). At intervals the rays take up a gyratory motion, tracing out spirals, sometimes in one direction, sometimes in the opposite direction (Figs. 5 and



PLANTE'S ELECTRICAL EXPERIMENTS.

6). Sometimes the points and rays all disappear on one side, and various curves, formed by those which remain, are drawn on the surface of the liquid. Lastly, when the speed of the gyratory motion is increased, all the rays vanish, and only concentric blue rings are seen (Fig. 7). The rings are the last phase of these transformations, which, examined either with the naked eye or by means of a lens, are very curious, and may be said to form a real *electric kaleidoscope.**

The production of these figures is explained by the great mobility of the luminous arcs or filaments which compose the ovoid flame formed between the water and the electrode. A careful examination of this form of spark proves that there is in reality a kind of tassel or *brush*, analogous to the brushes of static electricity, but more complete by reason of the greater quantity of electricity coming into play. These luminous filaments being in a state of continual agitation, the points where they meet the surface of the liquid are constantly displaced, and form the rays observed. Their gyratory motion arises from the flow of the electric discharge. As to the rings, these are formed, in a manner visible to the eye of the observer, by the motion, more or less rapid, of the blue points, and by the persistence of the impression on the retina.

When the metallic electrode is positive, and the distilled water negative, the spark still assumes an ovoid form; but the middle is traversed by a core of violet light. When two metallic electrodes are employed, a luminous spheroid is obtained, the interior of which is traversed by a brilliant track. This appearance resembles that of the path and corona of the spark from currents of induction, except that here the corona occupies a proportionally greater space by reason of the greater quantity of electricity. In fact, if the length of the interposed column of water is considerably augmented, nothing but an arc or rectilinear track is obtained.

In these experiments it is not necessary to bring the electrode into actual contact with the water to determine the passage of the electric discharge. The tension of the battery, although the component couples are not very highly insulated, is sufficiently great to cause the spark to occur spontaneously through a distance of about 1 mm. from the surface of the liquid.

This current will also flow through rarefied air, and brilliantly illuminates Geissler tubes if not too much attenuated, producing the stratifications observed under analogous conditions by MM. Gassiot, Warren de la Rue, and H. W Müller. With a single column of water in circuit it is possible, with a single discharge from the battery, to keep a Geissler tube illuminated for upward of three hours and a half, owing to the small quantity of electricity expended in passing through the rarefied air.

These experiments form a sequel to those which I have already made known in explaining the mode of formation of the *globular thunderbolt*. They show that with electricity of sufficient quantity and tension one can obtain not only electrified liquid globules, but also the electric spark itself in the globular form. This kind of thunderbolt should, therefore, result from the production of an abundant flow of electricity in the dynamic state, in which quantity is joined with high potential. The particular case in which fulminatory globes present slow movements or become stationary is explained by the motion or repose of the column of moist air, highly electrified and invisible, which serves as an electrode. To imitate this effect it is only necessary in one of the preceding experiments to cause the electrode, previously suspended in the form of a long pendulum, to vibrate above a vessel filled with water, or a metallic surface, and to hide its lower extremity by means of a screen. A small *ball of fire* is then seen to move along the water or conducting surface, reproducing all the appearances of the natural phenomenon.

* These phenomena are comparable with those observed by M. Fernet with induction currents; they also offer a close resemblance to those which result from the falling of liquid drops upon a plane surface, and which have been examined by MM. Helmholtz, Thomson, Maxwell, Tait, Rogers, Worthington, Trawbridge, &c.

ACTION OF LIGHT UPON OXALIC ACID.

ARTHUR DOWNES, M.D., and THOMAS P. BLUNT, M.A., Oxon., F.C.S. In the course of an investigation into the physiological action of light upon minute organisms, the results of which are embodied in a paper read before the Royal Society on the 6th inst., we observed that oxalic acid in a solution of decinormal strength is entirely destroyed when freely exposed to sunlight for some time; a similar solution under parallel conditions, with one exception—that the tube containing it was encased in an opaque material—remaining, to all appearance, entirely unchanged.

The destruction of the oxalic acid in the insolated tube was so complete at the end of two months, when the solution was examined, that it had no action on litmus paper, and gave no precipitate with calcium chloride; the reaction with potassium permanganate was so slight as to be scarcely appreciable. The nature of the change—whether it be the result of oxidation or of pure disintegration of the molecule—will form the subject of a future inquiry, but we think the fact itself is of sufficient interest for chemists to justify the present communication. One obvious inference of a practical character is that analysts who still use oxalic acid as a standard should protect the solution from light.—*Chem. News.*

MODIFICATION OF BELL'S TELEPHONE.

By M. TROUVE.

THE author states that the apparatus of Mr. Bell, on ordinary lines, only transmits the voice to relatively short distances, in consequence of the weakness of the currents produced by the manipulator. He therefore substitutes for the single membrane of Bell's telephone a cubic chamber, of which each surface with the exception of one is formed by a vibrating membrane. Each of these membranes, thrown into vibration by the same sound, acts upon a fixed magnet fitted with an electric circuit. In this manner, by associating all the currents produced by these magnets, there is obtained a single intensity, which increases in proportion to the number of the magnets influenced. For the cube we may substitute a polyhedron, the faces of which are formed of an indefinite number of vibrating membranes, in order to obtain the desired intensity.

BATTERY IN WHICH THE ELECTRODE ATTACKED IS OF CHARCOAL OR COKE.

By M. JABLOCHKOFF.

THE author fuses nitrate of potash or of soda, and plunges into this coke as attackable electrode and as non-attackable platinum or cast iron. The latter electrode, made in the form of a pot, serves at the same time as a recipient for the melted niter.

THE TELEPHONE.

THE interest which Mr. Graham Bell's telephone has aroused among scientific men is extraordinary. We hear in all quarters of experiments being made in connection with it, with a view to throw light upon its mode of action. Mr. Bell and others are striving to measure the strength of the electrical currents induced by the vibration of the iron diaphragm. These currents are of extreme feebleness, and are incompetent to affect the most delicate galvanometer or electrometer, since they rapidly succeed each other in opposite directions. Other physicists are investigating the mode of vibration of the iron membrane, and the part played by the steel magnetic core. The subject is full of interest. On the 21st inst., Mr. W. H. Preece gave a lecture, at the United Service Institution, on "The Application of the Telephone to Naval and Military Purposes," and on Feb. 1 the same eminent telegraphist is announced to give the Royal Institution Friday evening lecture on the telephone. At the next meeting of the Physical Society, Jan. 15, Mr. Preece will read a paper "On some Physical Points connected with the Telephone."—*Academy.*

NEW BATTERY WITH A SINGLE LIQUID.—The electrodes are zinc and graphite, and the liquid is an aqueous solution of the mixture known as glass-gall.—T. JOURDAIN, *in Comptes Rendus.*

IMPROVED ELECTRO-MAGNETIC RAILWAY BRAKE.

ALTHOUGH the electric brake known in France by the name of its inventor, M. Achard, has been more or less under public notice for many years, it is only latterly that it has been developed into anything like a practical form, and has met with some approval at the hands of French railway companies. In fact, during the last eighteen months, a train equipped with the brake has been running regularly between Paris and Creil and Paris and Abancourt on the Northern Railroad of France.

The accompanying illustration represents the brake as applied to a locomotive and a tender. Normally, the cylindrical electro-magnet employed ought to be concentric with the axle and move with it; the armature would form the sides of a sleeve also mounted on the axle, but loose, so that it does not revolve with the wheels; a chain forming the transmission to the brake is rolled on the surface of the sleeve, and produces a braking effect proportional to the advance of the train. This arrangement, however, required modification on account of the speed given to the parts if they are mounted direct on the axle. The principle, however, has been preserved by employing a shaft parallel to the axle, and which is geared up to this latter by the friction of a disk kept in place by a spring. The velocity is thus reduced, and the duration of the various parts increased, while the working of the brake is assured. It is obvious that this mechanism may be easily adapted to all types of carriages. In each of the brakes represented in the engraving the following parts are combined: The axle driving by friction the disk mounted on the adjacent shaft; a spring keeping the disk in contact with the axle; an electro-magnet mounted on the shaft parallel to the axle, and caused to revolve; two sleeves loose on the shaft parallel to the axle; these sleeves are terminated by two disks in soft iron, forming armatures, and of a diameter equal to that of the electro-magnet; the chain which actuates the brake by rolling around the sleeves when these latter become connected to the magnet by the action of the current. This chain passes over a pulley attached to the frame, and thence over another pulley at the end of a lever which is attached to the brake. The electric portion of the apparatus comprises batteries and conductors. Two insulated cables are placed below the frames of the carriages, one on the right, the other on the left, along the train. The connections between the vehicles consist of two uninterrupted metallic conductors. A complete electric circuit is thus obtained, by which the current is distributed throughout the train. Under each vehicle two secondary wires branch from the principal cables, one to the right, the other to the left Thus two branches, suitably insulated, conduct the current desired from the circular electro-magnet, the principal organ of the brake. In the front and in the rear van is placed an accumulating Planté's battery, composed of four secondary elements of 4 in. diameter. These batteries remain constantly charged, and they are sufficiently powerful to stop promptly a train composed of fourteen vehicles, including the engine and tender. In the front van above the battery is placed a commutator; a horizontal frame sliding in the roof of the vehicle allows the guard, by a lateral movement, to throw the metallic connection on the springs of the commutator; he also puts in communication the positive pole of the battery with the right-hand cable, and the negative pole with the left-hand cable; this is the only movement required to put on the brakes. A similar frame, mounted like the other, serves to release it. Equally the brake can be put in operation by the driver, a cord being attached to each end of the frame and led to the foot-plate, so that by pulling one or other of these cords the brake is thrown on or off; the train is therefore under the control of the driver and of the front and rear guards.

After a variety of experiments with different electro-magnets, M. Achard found that form designed by M. Nicklés, and indicated in the engraving, to be the best. In this magnet there are two tubes of soft iron, one placed concentrically within the other, the interval being filled with wires covered with silk, and through which the current passes. If an iron armature connecting the two cylindrical tubes is applied, a second pole is found on the outer periphery, and the field of magnetic attraction is largely increased. The great advantage of this annular arrangement is that the attraction is exerted, as it were, at the end of a long lever, which produces the best effect. Moreover, the employment of tubes insures a maximum of power, with a minimum of mass. M. Achard's magnets support about 1,760 lbs., with a current from a Leclanché battery of three or four elements.

Such is the arrangement of the electric brake at present working, a very different apparatus to that some time ago presented by the same inventor, who has devoted himself successfully to reducing the once complicated mechanism to the simplest form compatible with the principle of the brake. Capable of being applied to all the vehicles of a train, it forms essentially a continuous brake, and is undoubtedly prompt in its action, and costs little or nothing for its maintenance. In the event, moreover, of a break-away, the forward part of the train can be stopped by the driver and the rear part by the guard in the end van. As we have already said, a train fitted with this brake has been running regularly for 18 months on the Northern Railway. and making, on an average, about 180 miles daily, and during this time it appears to have given every satisfaction to the engineers on the line. In concluding this notice, we think it will be interesting to give the views of a well-known French engineer on continuous brakes. The observations are taken from a report of M. Marcel Deprez: "The utility of continuous brakes lies less, as is generally believed, in insuring a diminution in the chances of collision than in the reduction of the time employed in traversing the distance between two stopping places. The perfection to which the system of signals and the general train service has been developed is the best guarantee against accidents. On the contrary, any improvement which has for its object the increase of the useful speed of trains should commend itself to the attention of the engineers of railway companies. It is in this direction that powerful brakes, and especially that of M. Achard, are of importance. It is evident that if, by means of a prompt action of the brake, and by a greater intensity of stopping power, the full speed of the train may be maintained for a longer period, a saving in time is effected. A minute thus gained may represent a kilometer traveled by the fast trains. In omnibus trains, having frequent stops, the smallest gain of time is of importance." In this country a melancholy experience has taught us that, contrary to the above deductions, the great advantage of an efficient continuous brake is to prevent accidents and not to save time.—*Engineering.*

Fig. 1.

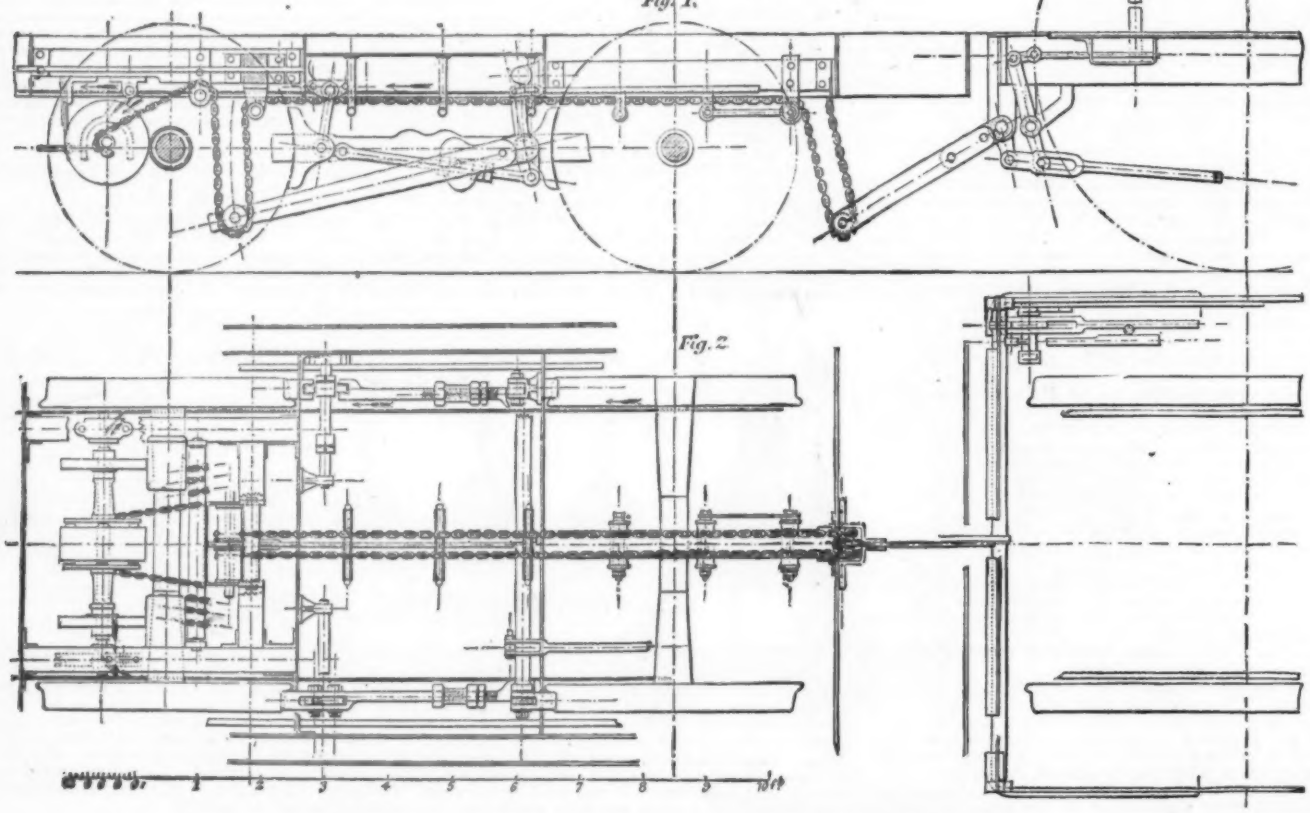


Fig. 2.

IMPROVED ELECTRO-MAGNETIC RAILWAY BRAKE.

FIRELESS AND HOT WATER LOCOMOTIVES.

During the last five years we have frequently referred to fireless locomotives and their progress toward practical use. Although these motors have attained some degree of excellence, yet we do not regard them as having by any means reached their highest point of usefulness. So far their only use has been on the ordinary street or suburban railways, but we regard them as peculiarly fitted for elevated and underground roads, especially the latter, because the gases of combustion, sparks, etc., prove a terrible nuisance in all underground railways. There appears to us, however, another direction in which they may be much more extensively used if our inventors will set their wits to work to make the necessary improvements to adapt this form of motor to the purpose of propelling private carriages on common roads.

The velocipede mania that so affected nearly everybody six or seven years ago showed one thing, if nothing more—the great need of some means of locomotion faster than the ordinary walk of humanity and not so expensive to keep as a horse. For a time it was fondly hoped by many that the velocipede would meet this desideratum, and our inventors did their best to make it do so, but all their efforts could not put more power into a man's legs than what originally belonged there, and the velocipede has had its day, it being now only found in the hands or between the legs of a few who make a living by exhibiting their skill in its use and of some enthusiasts who still believe in it.

If our inventors will spend as much time and thought upon adapting the fireless locomotive to the use of private individuals as they have spent upon the velocipede, it seems to us that the field of its operations may be very much enlarged, and that we may see the time when it will be almost as common for families to have steam carriages of their own as it now is to have sewing machines. We regard this as a promising field for operations for our inventors and a comparatively new one, which if faithfully and intelligently worked will insure a rich reward to the one who best succeeds in his endeavors.

At first glance, it would seem as though there would be much difficulty in the matter from the supposed necessity of the owner of the carriage also having a boiler to heat the water. We do not, however, regard this as absolutely necessary, because if such carriages were introduced and in common use, there could and would soon be depots established to supply the hot water, and where also could be stored the carriages when not in use; or companies might be organized to keep such carriages for hire, in the same manner as horses and carriages are now in livery stables. Besides this, it is possible that some cheap boiler may be invented that will heat water sufficiently for this purpose, which any person of ordinary sense might run without danger of exploding it; and just here seems a good chance for one improvement.

That our readers may have some idea as to what has already been done in the line of fireless and hot water locomotives, we propose to give sketches of the various patents granted that seem to have a bearing on this matter.

The idea of using hot water locomotives is very old, much older apparently than the Patent Office examiners have any idea, judging from the patents granted during the last ten years. As long ago as 1819, John Seaward obtained an English patent (No. 4,356), in which the fire was separate from the generator or boiler. In this case the generator was made to receive a cylinder or cylinders of cast iron, which were to be heated in a separate furnace and then transferred to the generator. Two forms of generators were described, in one of which the heater was inclosed in the steam space and a small continuous stream of water forced into the generator, and by direct contact with the heated iron the water was instantly flashed into steam, which was intended to be used as fast as generated. In the other style of generator the heater simply took the place of the fire in the ordinary boiler, as the water did not come in direct contact with the heater but only with the surface of the metal surrounding it, which derived caloric from the heater in the same manner as the ordinary box sad iron obtains it from the contained heater

Succeeding this we find another English patent, No. 6,923, granted in 1835 to that prolific but rather erratic genius, the Earl of Dundonald, in which various inventions are described. One part of this patent describes a mode of heating locomotive boilers by forcing steam into them from an auxiliary stationary boiler, so as to heat the metal of the locomotive boiler and thereby lessen the time required to get up steam, and then to heat the water by blowing steam

into it; or, after the steam had heated the locomotive boiler sufficiently, boiling water from the stationary boiler was to be transferred to it. Another plan, which we give in the inventor's own words, was as follows: "For locomotive boilers which are only required to travel over short lines of railroad, so as not to require a great supply of water before they return to the station or place from which they set out, the boilers of such locomotive engines may be supplied with hot water from the auxiliary boiler before mentioned without using forcing feed pumps to inject water into the locomotive boilers, but in lieu thereof retaining the steam in the auxiliary boiler at a higher pressure than the steam of the locomotive engine. Then a communication being established between the lower part of the auxiliary boiler and the locomotive boiler by suitable joints or flexible pipes, a supply of hot water may be transferred instantaneously from the auxiliary boiler to the locomotive boiler by merely opening a cock."

In another English patent, No. 2,995, of 1858, in which the invention is said to be applicable to "stationary, marine, or locomotive boilers," a method of heating water is described by passing it, before it enters the boiler, through a series of zigzag tubes arranged over the fire in a separate furnace. The water thus heated "is converted into steam, or steam mixed with water, and it thus enters into the boiler in a superheated or highly heated condition, and materially aids the generation of steam in the boiler. * * * Instead of thus heating the feed water and passing it in the form of hot water or steam, or both, into the body of the boiler, steam itself obtained from a separate source is used for a similar purpose. For this purpose a supply of steam is raised in a separate boiler or boilers and passed thence through a coil of heating pipes in the furnace. The steam is in this way highly superheated or surcharged with caloric, and as it at once permeates the mass of water in the boiler it generates steam with great rapidity and effect therein. Steam applied in this way may operate on a boiler which has no furnace of its own, in which case the injected steam acts entirely in the place of fuel."

Following this is another English patent, No. 143, of 1862, issued to W. Jopling, which describes the idea of heating water, previous to feeding it into a locomotive boiler, by means of a separate stationary boiler, which may or may not be connected with a furnace for heating fuel to be supplied hot to the furnace of the locomotive.

The late Zerah Colburn contributed an article in 1864 to the London *Engineer* (vol. XVIII., p. 335), in which the advantages of employing fireless locomotives in working the underground railways of that city were discussed at considerable length, showing the decrease in material to be carried, lower first cost of the locomotives, less expense in running, and the dispensing with the smoke and dust inseparable from the employment of the ordinary locomotives, which prove such nuisances in all tunnels, to say nothing of the effect on the lungs of sickly persons, effects which are much increased where there is much traffic, as in the London underground railways.

The same gentleman also furnished an article to the same paper (vol. XIX., p. 282) advocating the use of stationary boilers to heat the feed water of locomotives to about 300° or 350° before supplying it to the tenders, which, of course, would have to be strong enough to sustain the pressure due to water at this degree of heat.

The next case we find is the American patent No. 70,407, issued to C. W. Cahoon November 5, 1867, showing a carriage containing two reservoirs connected by a pipe having a valve for cutting off the connection when desired. Each of these reservoirs is supplied with a pipe and valve connecting it with the engine, by which arrangement the steam in one reservoir can be held in reserve until the other is exhausted, or, if preferred, the cylinders can be both in communication through the pipe and valve before referred to, and the steam be used from both at once. When the steam carriage is to be used, water, it is stated, "is first heated at a stationary boiler under pressure up to a temperature of about 330°. This boiler has two pipes with valves in one end of it, to which are attached adjustable couplings, one of which pipes is placed near the lower part, and the other at about two thirds of the height of the water space. When it is desired to fill the tanks the carriage is brought alongside of the boiler, and the lower pipe in one of the tanks connected with the lower pipe in the boiler, by means of the adjustable couplings, the upper pipes of the two being connected likewise. The valves in the boiler and tank are then opened, so that the tank may be supplied thereby, and when supplied the valves of both are shut and the coupling disconnected, the carriage being then ready for duty. If both tanks are to be filled at the same time, then the valve between them should be opened before connecting the tank and boiler, and after filling be immediately shut. * * * * The length of time during which the water will be available for motive power will depend upon its heat, and when that becomes too much reduced the tanks are to be replenished from the stationary boilers, which may, for use on street railways, be placed at either end of the line, or, for long roads, may be placed at distances to correspond with the quantity of water carried and the heat of the same."

The same gentleman has a subsequent patent, No. 85,457, dated October 27, 1868, describing the use of a flexible-jointed pipe for connecting the reservoirs to the boiler during the process of filling the former with hot water, and a supplementary tank to be attached to the stationary boiler for the purpose of receiving the water left in the reservoir when the pressure has become too low for further use, which water is to be returned to the boiler for reheating. The use of the supplementary tank is to enable the water to be emptied from the reservoir into the boiler by the pressure of the steam still remaining in the reservoir, although it may be considerably below that in the boiler. This is done by cutting off the connection between the boiler and supplementary tank, connecting the reservoir with the tank so that the water in the reservoir may be driven into the tank by the force of the steam still remaining, and when emptied closing the connection between the tank and reservoir, filling the latter with the highly heated water, and then, by opening the connection between the tank and boiler, allowing the water to descend into the latter by its own gravity.

The next patent on this subject is that of Gartner & Diebold, of Lebanon, Pa., December 12, 1871, No. 121,864, the novelty of which, to use the words of the inventors, "consists in the propulsion of cars or machinery of a portable nature by means of steam which has been generated in an apparatus apart or separated from that in which it is applied as a motor, and conveyed to capacious reservoirs connected with a steam cylinder, to be kept and used as required."

The drawing shows an ordinary street car having beneath it a reservoir to receive the steam, and a condenser to receive and condense it after it has been used in the propelling engine, situated between the reservoir and condenser.

A few months after this (April 9, 1872) the patent No. 125,577 was granted to Emile Lamm, of New Orleans, for the use of hot water in precisely the same manner as steam is used in Gartner & Diebold's patent and hot water in the Cahoon patents. The following is extracted from the specification: "The purpose of my invention is to store heat in a mass of water or superheat the water until its temperature corresponds in a steam boiler to two hundred pounds pressure to the square inch. I then drive this superheated water into a strong reservoir placed on a street car or other vehicle, to which a steam engine connected with the above reservoir is adapted. * * * * The surplus heat which has been produced in the stationary boiler is carried along with the water when transferred into the reservoir on the car. This superheated or stored heat, without any additional fire on the car, causes about 15 per cent of the water in the reser voir to fly off into steam, with an average pressure of one hundred pounds to the square inch, thereby enabling the car to run a distance of at least seven or eight miles."

The drawing in this case shows only a reservoir to receive the heated water and a cylinder of an engine to use the steam derived from it.

The same gentleman obtained another patent (No. 129,969), July 30 of the same year, which shows a reservoir of a fireless locomotive, having in its bottom a perforated pipe through which steam may be driven into the cooled water of the reservoir to heat it, after a trip has been made and the water become comparatively cool.

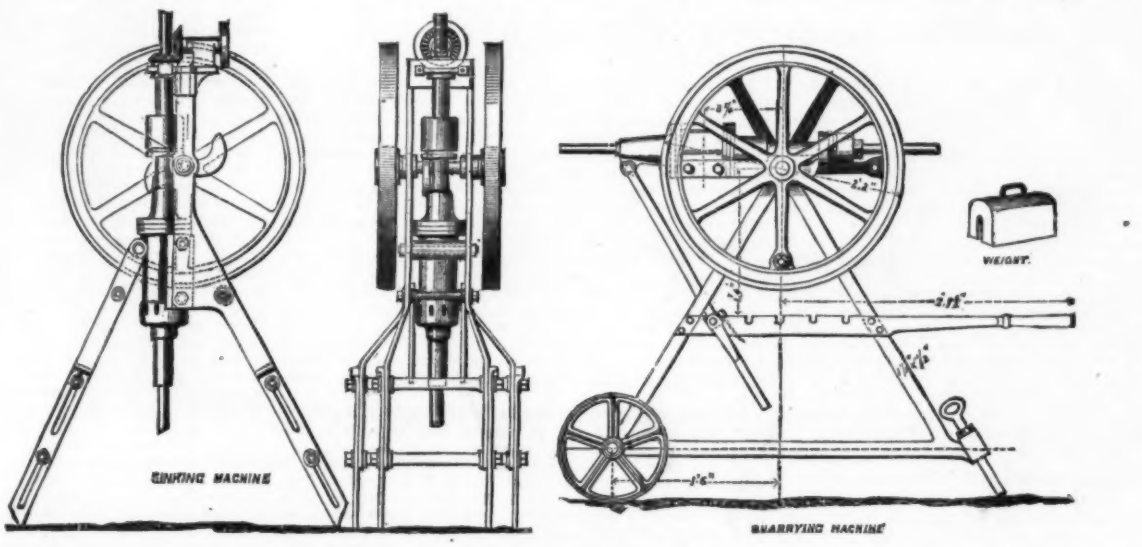
After this comes an English patent, No. 4,377, of 1875, issued to T. C. Fidler, in which is described the use of "heaters" (blocks of iron or fire clay), to be heated in stationary furnaces, which will give off sufficient heat to supply steam for a limited trip. At convenient points stationary furnaces are to be employed to reheat the "heaters," where the cool heaters are to be exchanged for hotter ones, or they are to be placed in connection with the furnaces so that currents of hot gases may be sent through them, the heaters being perforated for that purpose. The locomotives may be of ordinary construction in other respects, supplied with the usual feed water tanks, etc., but preference is given to the employment of a stationary boiler heated by the gases of a stationary furnace for the purpose of supplying the whole of the locomotives or steam cars with heated feed water between each trip, sufficient to compensate for the loss of water for the whole trip, and to fill the boilers with heated water for the first trip of the day, in order to dispense with the weight of the tanks, feed water apparatus, etc., upon the locomotives or steam cars.

The next and last patent we shall refer to is that granted November 27, 1877, to E. H. Angamar, of New Orleans, for an invention which is stated to consist mainly in "providing the motive heat for a railroad car on short routes by supplying its boiler with water previously heated by means independent of the car, and keeping up this initial heat of the boiler by a furnace transported with the car; or, in other words, in supplying the feed water, at or near the requisite heat and pressure, from a stationary boiler or furnace, and sustaining that heat and pressure subsequently during the trip by the car boiler and furnace." Besides this main feature of the invention there are details shown for carrying out this principal point. One of these consists in the use of a movable grate, to be filled with incandescent fuel from the furnace belonging to the stationary boiler, which, when so filled, is to be connected with the boiler of the car or locomotive to keep up the supply of steam as it is used during the trip, the size of the grate and quantity of fuel being so proportioned as to keep up just sufficient steam without further feeding during the trip. If preferred, instead of the solid incandescent fuel, liquid or other fuel to be fed to the furnace during the trip may be used. A second minor feature is the heating the supply water by means of two tiers of boilers, the upper tier being heated from the waste heat of the lower boilers and the water for the lower tier being first fed into the upper tier, where it is heated to about 212° before it is passed into the lower boilers. These two sets of boilers are so connected by pipes with the coupling connecting them with the locomotive, that, if preferred, the lower portion of the locomotive boiler may be filled with water from the upper tier and the upper portion of the water space be filled from the lower tier at a higher degree of heat.

From these brief descriptions of the different patents it will be seen that, although several of the American patents—Cahoon, Gartner & Diebold, Lamm, and Angamar—have broad claims to the idea of using hot water or steam in locomotives taken from stationary boilers, yet it is evident that no such broad claims can be sustained in view of the earlier foreign patents for the same thing, and that therefore there can be no monopoly of this feature, which leaves the system open to whoever can produce the best means of utilizing it.

There are, no doubt, many different points on which improvements may be made, even for use on street and other railroads, but the greatest chance for improvements is in adapting the principle for use in private carriages, small steam yachts, and even ferryboats, all three of these being new and untrod paths, in which he who starts earliest, all other things being equal, has the best chance. To say nothing further of the use of these motors for private carriages on ordinary roads, think of the immense business that could be done in summer time on our many rivers, lakes, and bays, if small yachts or boats could be obtained provided with powers that would, within certain defined limits as to distance, take them in any desired direction, irrespective of the wind or tide, without the expenditure of muscular power other than that sufficient to turn a valve, and only requiring such attention as any child can give.

How these desirable results are to be reached, and by what improvements, we shall have to leave our inventors to find out. There are many different points which will require improving without doubt; and it is probable that all these will not be made by any one man, but that, as in the case of most inventions, the complete and perfect motor will grow up from a union of the ideas of many inventors, no one of whom will be able to claim all the glory or all the profit, so that the inventor has more than one chance of succeeding. Let no one, however, start off with the idea that a practical motor of this kind can be devised without the expenditure of considerable thought, time, perseverance, and last, though not least, money, or he will most certainly fail in his endeavors.



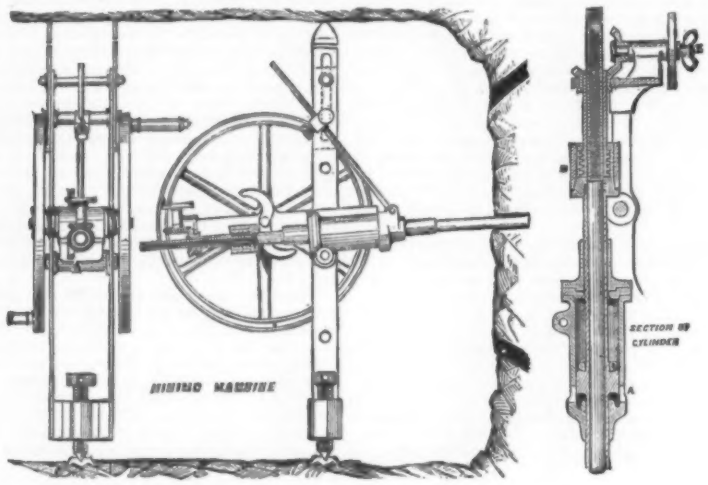
IMPROVED HAND-POWER ROCK DRILL.

JORDAN'S machine is made in various forms to suit the different conditions under which it has to work, but the cylinder and drill bar, together with all the parts requisite to give motion to the tool, are of the same construction in each case. The cylinder is fitted with a piston and tubular rod of steel, which works freely through the long glands at the top and bottom of the cylinder. The top gland contains a cup-leather packing round the piston rod, which prevents the escape of air contained in the cylinder. The piston is slightly cupped on its upper surface, and is packed with a thin disk of leather, which, when pressed down into it by a nut of proper form on the piston rod, is converted into a cupped leather, which, being very thin, forms an air-tight packing and permits a very free motion of the piston.

The top of the tubular piston is fitted with a lifting block made in three parts—see section of cylinder—two of which form its body, and one the sleeve, by which all are held together. This construction is adopted in order to embrace the driving nut B—see detail—the lower end of which revolves in it as a thrust-bearing. This nut is screwed through its entire length of 8 ins. to fit the screw portion of the steel drill-bar, which passes through the center of the ma-

chine and carries the boring tool at its lower end. The drill-bar is screwed for about half its length, and the other or lower hexagonal half passes through a cap of similar form at the lower end of the tubular piston rod, so that it must turn with the piston while having independent longitudinal motion through its center. A somewhat similar arrangement admits of the long driving nut either turning with or remaining without revolution on the drill-bar, while it is always at liberty to travel through the bevel wheel connected with the feed hand-wheel. The requisite motion is given to the drill-rod by two cams—see mining machine—on the wheel shaft.

It will be seen that at the lower part of the cylinder a number of holes, A, are made for the admission of air, which in the upward stroke of the piston is compressed in the top part of the cylinder sufficiently to cause the downward stroke to be made with great velocity as soon as the cam has passed the collar. The revolving motion of the bar is secured by the air ple frictional contact of the cam against the collar as the former revolves. The collar imparts this



IMPROVED HAND-POWER ROCK DRILL.

motion to the sleeve on the boring bar, and the rate of feed is regulated by causing the sleeve to revolve against more or less resistance, visited upon it by the thumb screw on the feeding wheel shown at E.

This arrangement forms an automatic adjustable feed. The machines are worked by two men, and the drill makes from about 140 to 180 strokes per minute. We recently saw some of the machines at work. The sinking machine has been proved capable of boring a hole from 1¼ in. to 1½ in. diameter to a depth of 6 ins. per minute in Portland stone when working at full speed. With the quarrying machine a 1¼ in. hole was, in our presence, bored to a depth of 3 ins. in one minute in Aberdeen granite. The mining machine is capable of piercing a horizontal hole 1½ in. diameter in the same granite at the rate of from 1½ to 1¾ in. per minute. Each machine worked by unskilled men is thus capable of doing the work of from two to four skilled men when boring by hand. The machines are kept steady in work by hanging weights on the cross bolts on the lower part of the framing. They are made by the Hand-power Drill Company, Queen Victoria Street, London.—*Engineer.*

THE HYDRAULIC RAM.

By C. L. Hett.

The first notice we find of an arrangement for utilizing the momentum of a column of water for raising a portion of itself to a higher level is in a letter written by Mr. John Whithurst, and published in the "Philosophical Transactions" for 1775. The letter describes an apparatus of which Fig. 1 is an illustration. It consists essentially of a reservoir of water, A, from which a fall pipe, B, is carried to the air vessel, H. A short pipe, E, terminating in a cock, F, branches from the main pipe before it reaches the air vessel, H; between this branch and the air vessel a small clack valve, G, is placed in a suitable enlargement of the pipe. A second pipe, or rising main, I, connects the air vessel with a tank, K, placed at a higher level than A.

The action is as follows:—The cock F being opened, water from the tank A flows down the drive pipe B, with a velocity varying with the fall. When a sufficient velocity has been attained, the cock F is closed by an attendant, and the column of water, in accordance with a well-known natural law, continues its course. Having no other outlet, it forces its way through the small valve G into the air vessel H, compressing the air contained therein until brought to rest by its reaction. The elasticity of the air in the chamber H, in return forces the water up the rising main I into the tank K.

By alternately opening and closing the cock F, a continous flow of water into the tank may be maintained. The air in the vessel H acts as an elastic spring, and converts the intermittent flow of water to the vessel into a steady stream from it. Without this arrangement, the whole column of water in the rising main would necessarily be put into motion, and stopped at each pulsation of the water in the delivery pipe. This with a short rising main would produce heavy jars, and in a longer one the water could not be put in motion in this intermittent manner.

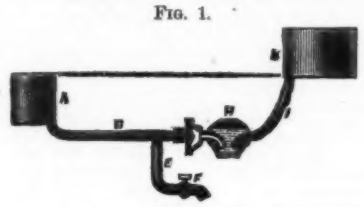
In 1773 Mr. Whithurst erected one of his machines for supplying a brewhouse at the seat of Philip Egerton, Esq., at Oulton, in Cheshire. In this instance the fall pipe was 1½ in. diameter and 200 yards in length. The cock E was fixed in the kitchen, 18 ft. or 20 ft. below the surface of water in the reservoir A. This cock being regularly used for drawing water for domestic purposes, and in almost constant action, it kept up a sufficient supply to the brewhouse.

The ram as left by Whithurst, although very ingenious, was very limited in its application, requiring, as it did, human aid to work the cock or escape valve.

In the year 1796 the celebrated Montgolfier invented a self-acting escape or pulse valve, which in its crudest form was patented by permission in this country by Mr. Boulton, of the firm of Boulton & Watt, in 1797. Fig. 2, reprinted from the specification, represents the ram in the form it had now assumed. The action will be easily understood. The water flows through the fall pipe C until it acquires sufficient momentum to lift the counter-weight E and close the valve B; when this takes place, as in the Whithurst machine, the water, having no other outlet, forces its way through the valve A into the air chamber J, and thence passes into the rising main D. The water in pipe C is soon brought to rest by the reaction of the compressed air contained in the air vessel, and the valve A then falls. At the moment the delivery valve closes there is a slight recoil or regurgitation in the drive pipe, which, together with the counterweight E, causes the pulse valve again to open. The action now commences afresh.

Montgolfier's patent includes various modifications of the ram. In one case a siphon fall pipe is used, in order to pass over any obstacle in its course instead of cutting through it; in another instance, two rams are designed to work with one fall pipe, in situations where a current of water passes alternately in opposite directions, as in a tidal river. One ram is placed at each end of the pipe and works alternately, according to the current. A third arrangement is for drainage purposes, where a stream flows at a higher level than that from which the water is to be removed. In this case the pulse valve is placed at the inlet end of the fall pipe. When it closes, the momentum of the water in the fall pipe carries it forward, leaving a partial vacuum behind it, which is filled by the water from the lower level passing through a suitable pipe and clack. This clack prevents any

Fig. 1.

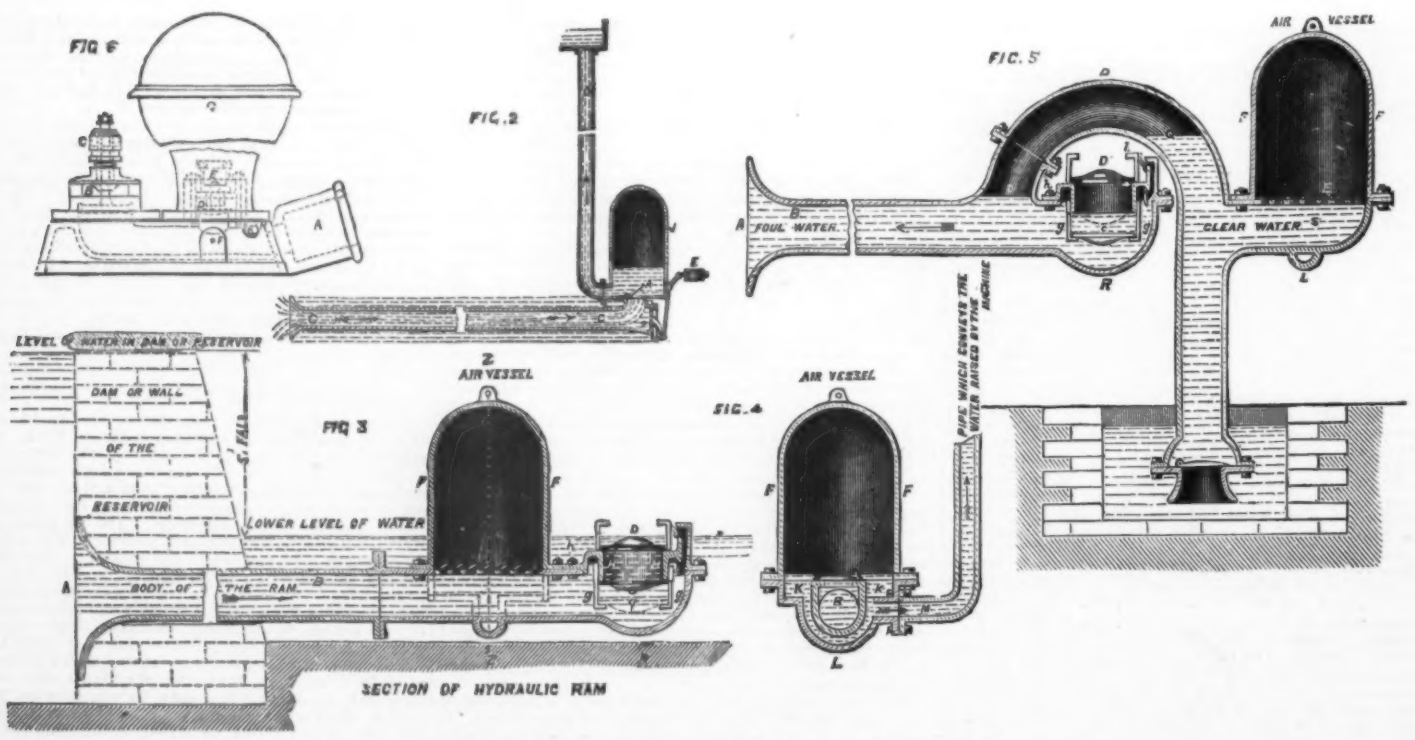


return of water, which thus passes out of the fall pipe with the rest of the liquid. After the registration of the patent, Montgolfier appears to have further improved the ram by the introduction of spindle valves with vertical lift, both for the escape and delivery.

From the foregoing it will be seen that the merit of the invention of the ram was undoubtedly due to Whithurst; Montgolfier, however, raised the machine from a position of but little practical value to that of a thoroughly efficient means of raising water. To such a perfect stage had it now arrived that many of the rams made at the present time possess no advantage over the best designs of Montgolfier.

Experience proved that the air in the air vessel was gradually absorbed by the water passing through it, and the working of the ram interfered with, in a greater or less degree, according to the height of lift and length of delivery pipe. The younger Montgolfier arranged a small valve so as to keep the vessel supplied with air. Figs. 3 and 4 represent the ram as improved and patented by him.

The most interesting points in this machine are the air cushions contained in the annular space I, and the means of maintaining a constant supply of air in it and the air vessel. Montgolfier speaks of the air cushion as if it had been used before the date of his patent, but claims the use in connection with the air-supplying arrangements of one of a larger size than had previously been practicable. Its object is to reduce the shock at the closing of the pulse valve; but we have not found it answer the purpose, or, indeed, to be of any use whatever. C is the pulse valve, working in guides *g g*; D is a similar valve, closing externally, the purpose of which will be afterward explained; L and K are two clack valves, closing either end of an air passage otherwise open to the atmosphere at one end and into the end of the ram at the other. The action is as follows:—While the water escapes through H H, the valve K is closed. As in the previously described rams, the valve C shuts—delivery into the air vessel takes place—and a recoil is set up, intensified in this case by the elasticity of the air cushions at I. The valves C and D both drop, and D prevents any return of the water through the escape passage.



HYDRAULIC RAMS.—THE EARLIEST AND THE LATEST.

The recoil of the water is sufficient to create a partial vacuum in the air space I. The valve K then opens and fresh air rushes in; the force of the entering air closes the valve L, and prevents too great a quantity gaining admission. The air thus admitted in excess of what is required to fill the space I rises and lodges under the delivery valves, to be forced into the air vessel at the next stroke.

The inventor has provided ample means for the delivery of the water to be raised by means of seven small clack valves, a provision which is insufficiently attended to in many modern rams. A ram with this arrangement of delivery valve was erected at St. Elloe.

The same patent includes an arrangement by which a stream of salt or impure water may be used for pumping pure water from a spring or well. Fig. 5 shows the arrangement. The working of the ram proper is exactly the same as in its more simple form. Assume the pipe Q T to be primed as shown in the drawing; at the moment the escape valve closes, the water rushes up the bent pipe P, compressing the air in it. The air forms a kind of piston, reacting on the surface of the water at Q, and forces it through the valves E into the air vessel. The water having

FIG. 7.

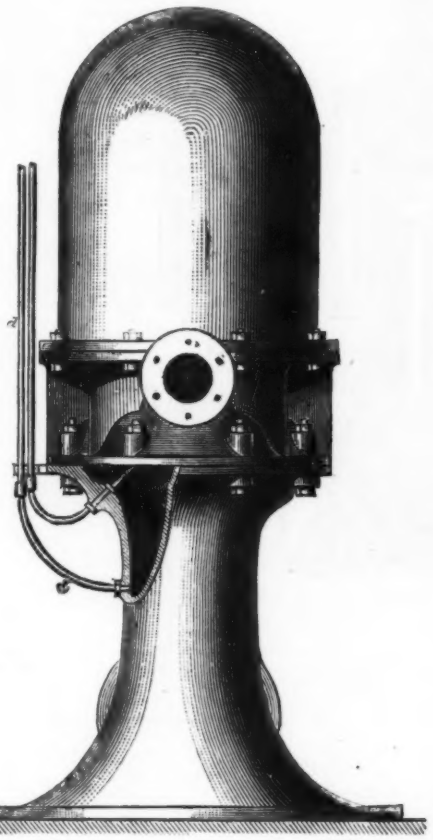
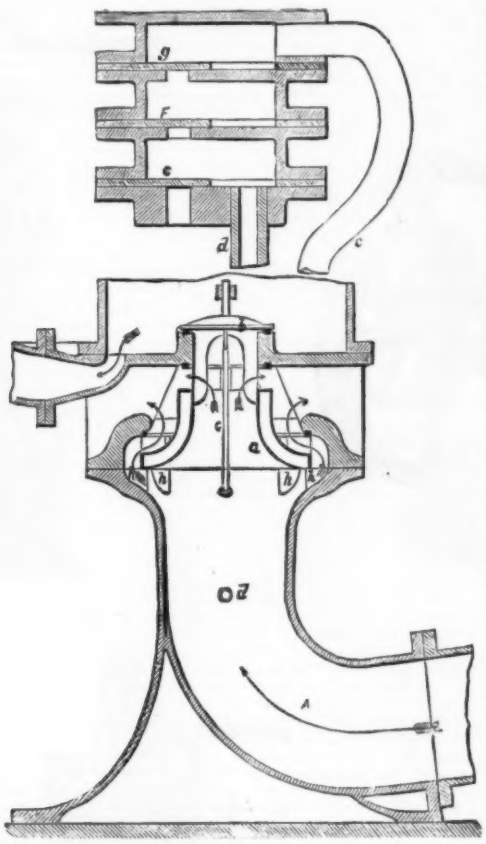


FIG. 8.



FISCHER'S HYDRAULIC RAM.

expended its energy, recoils with very great violence, being assisted by the expansion of the air at P. This recoil produces a partial vacuum. The entrance through H being closed by the valve D, the pressure of the atmosphere on the surface of the water whence the pure supply is drawn forces a portion of it through the foot valve, into the rising pipe T Q. The water recommences to flow, and the action is repeated.

The manufacture of rams in England was for a long time carried on almost entirely by Messrs. Easton, of London, who introduced various alterations in their construction. The size of the air cushion was much increased, and we believe the introduction of ball delivery valves and double pulse valves is due to them. Mr. Glynn, in his "Power of Water," states that a patent was taken out by this firm for their improvements; but a careful search in the indexes published by the Commissioners of Patents, for such a specification, has been entirely unsuccessful. The ram was comparatively unknown to the general public at this period of practical monopoly. An amusing proof of this occurred in 1832, when a correspondent, writing to the old *Mechanics' Magazine*, described one of a very crude design as an entirely new invention. Mr. Freeman Roe appears to have entered the English field soon after this date. His ram and that of Messrs. Easton & Amos were exhibited in the Exhibition of 1851, and submitted to a series of trials under the direction of the jurors. It is to be regretted that no particulars of the dimensions of these rams are on record, as without them the results obtained are of no practical value. Our American cousins appear to have so far appreciated this means of raising water as to induce Messrs. Douglas, of Middlestown, Connecticut, to take up the manufacture, and exhibit at the fair held at New York in 1847, where a silver medal was awarded them by the American Institute. Their ram is well arranged, and is designed so as to be produced at a very low cost. The escape valve works in a short cylinder, and is guided by a perforated shrouding. The stroke is adjustable by means of a screw, which is very much better than the clumsy expedient of packing the valve up with washers on the spindle, which is still adhered to by some of our English makers. The objectionable points are the leather clack delivery valve, the want of an air supplying arrangement, or snift valve, and insufficient strength for high falls and lifts. For use with low falls, and where the water is not carried very far, the type introduced by Mr. Douglas is so good a one that the writer has commenced making rams of this class, with improvements suggested by experience, for use under such circumstances. In 1848 the same makers introduced a pumping ram of original design. The air piston of Montgolfier was replaced by a diaphragm inclosed in a globular chamber, one side of which was in contact and pulsated with the water in the body of the ram. To the center of the diaphragm a rod was attached, which communicated its motion to a lever working a common force pump. The use of the diaphragm was an important step, but the mode of transmitting its movement to the water to be raised was very roundabout. Mr. Douglas has latterly used a piston working in a cylinder in place of the diaphragm, which appears to be a very doubtful improvement.

In 1852 an English patent was granted to Thomas Hanson, of New York, for further improvements, consisting of (1) a leather clack, for preventing the recoil in the fall pipe taking place, and (2) for a disk delivery valve, working into a short cylinder, the periphery being made water-tight by means of a cup leather such as is used for the bucket of a common pump. Neither plan appears to have met with sufficient success to be at all generally adopted. This patent may be said to have completed the history of the American rams. Although other makers have entered the field, their productions are generally but very slightly modified copies of Douglas'.

Messrs. Bollie & Son obtained provisional protection, under our English law, for improvements in hydraulic rams, in 1862, and also exhibited a specimen in the Exhibition at London in that year. Their improvements consist in a counterbalanced escape valve, which is designed so as to stop the escape of the water before the valve reaches its seat, thus mitigating the shock which takes place. The second improvement is a rather complicated air pump for supplying the air vessel. Neither of these novelties has come into use in this country.

The next patent taken out in England is for the application of disk valves of India-rubber, or other flexible material, to the simple ram, and their combination with the flexible diaphragm of Douglas in the pumping ram.

After considerable experience and a long course of experiments, the writer has adopted the form shown in Fig. 6 in his own practice. The machine is arranged so as to give access to all the working parts without disconnecting any of the pipes. When the air vessel is removed, which is done by unscrewing four nuts, the delivery valve is exposed. The size of the escape valve is arranged so that while it is not unnecessarily large, its area is sufficient to insure delivery at a high elevation, it is adjustable by a suitable screw arrangement. The delivery valve is of disk type, with a spherical face. This gives a much larger area than a ball valve of equal weight, and is found by experiment to give much greater efficiency than a ball valve. Provision is made for adjusting the lift of this valve, which is a point of great importance in the working of the machine. The air vessel is made very large, to insure a uniform motion of the water in the delivery pipe; it is supplied with a snift valve of the ordinary form. The delivery valve seat and adjustments should be made of gun-metal, also the guides and adjustments of the escape valve. The nuts holding down the air vessel should also be gun-metal, so as to prevent their setting fast and rendering access to the delivery valve difficult. The studs are preferable when made of Lowmoor iron, thus avoiding any chance of their twisting off. The various parts should be made to templates, and the workmanship should be equal to first-class engine work. It should always be borne in mind that while engines will "go" when very inaccurately made, a ram will not answer without very perfect fitting. A very slight inaccuracy in fitting, which would pass unnoticed in the valves of a pump, is sufficient to greatly impair or quite suspend the useful action of a ram.

In a recent paper to the Hanoverian *Bezirksverein*, Mr. Hermann Fischer states that in the year 1866 he was charged to devise for the town waterworks in Malmö a hydraulic ram, which required a width of one meter for the inlet pipe. With a view to diminishing the considerable shock of the water on the water mass at rest in a given moment between the outflow valve and the pressure valve, he sought especially to place these two valves as close together as possible, and he arrived at the construction indicated in Figures 7 and 8.

The outflow valve *a* is constructed as a double seat valve and hollow. It rests in the open state on the eight noses *h h*, and is guided below by as many bars, placed above the noses *h h*; above, by the wings of the pressure valve; the valve seats are formed of caoutchouc rings.

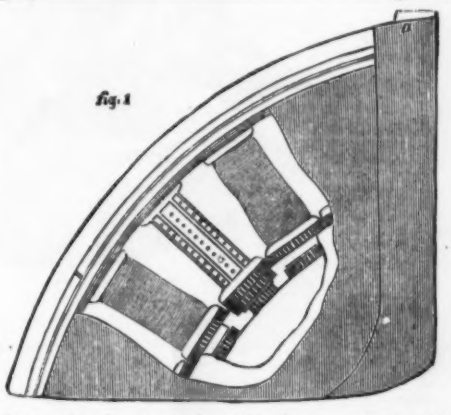
From the figures will first be observed the large cross section of outflow; further, that only in the neck of *b* is there any water during the opening of *a* in the state of rest. The shock of the water can, therefore, be but small. To further reduce it, the arrangement shown above Fig. 8 is adopted. From the pressure pipe *a* a narrow pipe *d* proceeds upward, terminating in the lower part of a triple chest, whose middle and upper parts communicate with the lower through the valves *f* and *g*, while the lower, after opening of the valve *e*, is put in communication with the open air. The upper part of the chest again communicates through the pipe *c* with the space under the valve *b*. Whenever the outflow valve *a* is closed, and consequently a shock occurs, water is forced upward in *d*, compresses the air there, and opening the valve *f*, forces it partly into the middle division of the chest. After cessation of the shock, this air passes through the valve *g* into the upper part of the chest, into the pipe *c* and lastly under the valve *b*; there it serves, first as a cushion for the impact of the water, and then for abundant replacement of the air which is gone out of the air vessel, so that the water streaming through the open valve *b* only meets air.

The ram described has not been constructed, but only a model with about 40 mm. width of inlet pipe. In the experiments referred to the audible shock was very small.—*Engineer.*

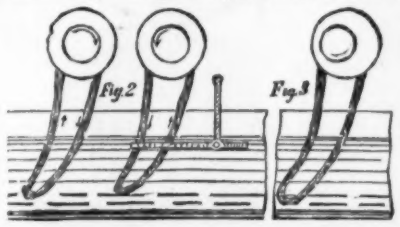
HANK DYEING, WASHING, OR SIZING MACHINE.

THE dyeing, washing, and sizing of yarns in the hank is still mostly done in tubs by hand; and though several machines have been invented, and are also in use for this purpose, their application is only limited. The machine which we here illustrate is, we think, worthy of consideration, being different from those which we have seen.

The dye-beck, D, Fig. 1, which contains the hanks, is slightly inclined so as to facilitate the flow of the liquor; the



hanks are placed upon perforated rollers or winces, which are made to rotate by suitable gearing, but in such a way that each wince turns in a contrary direction to that of its neighbor, in order to avoid entanglement of the yarn; the lower half of the hank floats thus in the liquor, or it may be put upon a submerged roller when desirable, and this latter made to have an oscillating motion, so as to imitate the shaking given to the hank by hand dyeing; this latter object is also attained by making the upper winces revolve eccentrically, as shown in Fig. 3. The liquor is contained in a vessel situated at a higher level, furnished with a thermometer and densimeter, and flows from this into the beck, where its level is regulated by ball valves, and whence it is pumped back into the cistern.



We should think that this machine, which is especially mentioned in *Le Jacquard*, would be more complete if there was also a contrivance for wringing the yarn, which is one of the main features of the English machines; for however well the yarn may be saturated, it will be unevenly dyed if not carefully and well wrung.—*Textile Manufacturer.*

PROTECTING METALLIC SURFACES.

THE metallic objects or metallic surfaces which it is intended to submit to the protecting process are either subjected to heat in a retort chamber or other apparatus which is capable of being heated externally and also of being wholly or partially closed, and to such retort chamber or apparatus a tube or tubes is or are adapted in order that air or oxygen, or mixtures of the same, may be allowed to pass over, in, and among the objects contained therein at any desired pressure; or, instead of causing the apparatus to be heated externally, he employs a heated current of air or of oxygen, or of an oxidizing agent composed of mixtures of the same, heated to such an extent as that the objects contained in the apparatus shall become oxidized, and thus become coated with a protective film or covering; or the apparatus containing the objects to be treated may be heated externally, and the before-mentioned oxidizing agents be admitted at the ordinary temperature of the atmosphere. The temperature which he has found to give the best results ranges from a dull to a bright-red heat, whether the objects be heated by the external application of heat or by the internal application of the heated oxidizing agent. The operation is continued until a protective film or covering of the desired thickness shall have been formed, and upon the objects being then allowed to cool they are ready for useful application in the arts.—G. BOWER, Author.

NEW DOUBLE-ACTION VERTICAL STEAM ENGINES.

WHILE the life of a portable engine driving a thrashing machine is not half that of a fixed engine of the same class kept properly housed, the cost of repairs to the portable would probably be found, if accurate account were kept, to be three times, and in some cases four times, that of the stationary engine properly protected. The value of encasing the working parts of a steam-engine, especially if running at a high speed, is generally allowed; but, at the same time, there is a natural and reasonable inclination toward having those same working parts readily got at for lubrication, adjustment, and repair. The great difficulty hitherto has been to reconcile these two *desiderata;* and, as a rule, wherever it is most necessary to have the parts cased in, so also is it most desirable that they be readily accessible.

In the engines lately exhibited at the Royal Agricultural Show, Liverpool, Mr. F. W. Turner, of the St. Alban's Ironworks, has solved the problem of completely encasing the working parts, while at the same time allowing them to be easily accessible. Nor is this the only advantage of his arrangement; for he greatly diminishes the number of parts, thus reducing the weight and cost of the engine; provides for continually freeing the cylinder of any water due to priming or condensation, thus dispensing with the usual cylinder-cock; and also lubricates the wearing surfaces with steam, so that no hot bearings need be feared, even if the supply of oil should be neglected.

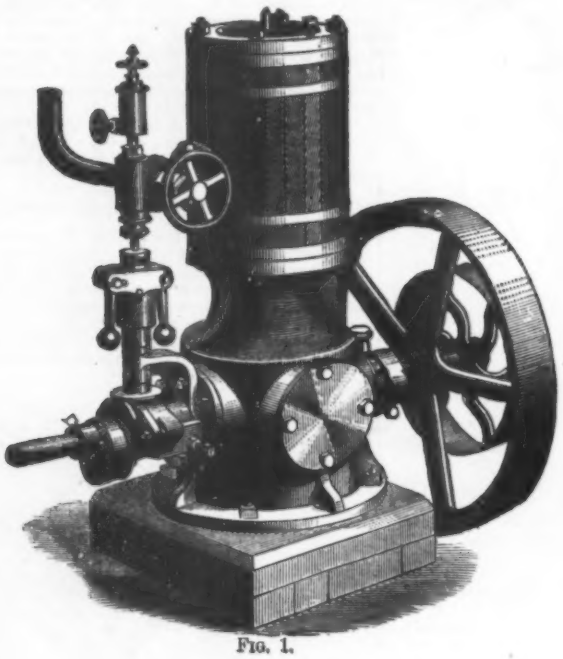


FIG. 1.

Fig. 1 gives a perspective view of the simplest form of these new high-speed engines, being double-acting but non-reversing; and Fig. 2 shows the same engine combined with a vertical boiler on a bed-plate forming feed heater, being the identical arrangement exhibited at Islington. This engine is admirably adapted for driving any light machinery at a high speed, where no change of direction is required. The cylinder, it will be seen, is bolted directly on to the top of a casting, which serves at the same time to carry the main bearings and to inclose the whole of the motion. The piston has a trunk formed on its lower end, working tight, of course in the lower end of the cylinder; and the pin in the upper end of the connecting rod is carried by brasses contained in the piston. The slide-valve works on a face formed on the piston itself, as will be explained in connection with the reversing engine, and is worked direct off an arm on the connecting rod. If, however, "lap" and "lead" are required, the valve is actuated by a separate rod, as in the reversing engines to be hereafter described. Steam from the boiler is admitted about the middle of the length of the cylinder, the admission being regulated by a high-speed governor placed immediately over the shaft and acting direct on an equilibrium valve. The up stroke is due to the pressure of steam on the under and annular surface of the piston, and the down stroke to the pressure of steam admitted by the slide-valve on to its whole upper or circular surface, the exhaust port being opened in the former case. This vertical engine and boiler, when tested by Messrs. Ransomes & Sims with the friction brake, gave out 5·1 actual horse-power per nominal horse-power, with steam in the boiler at 85 lbs. pressure led for a distance of 12 feet by a naked steam pipe, lifting 150 lbs. on a wheel circumference of 15 feet.

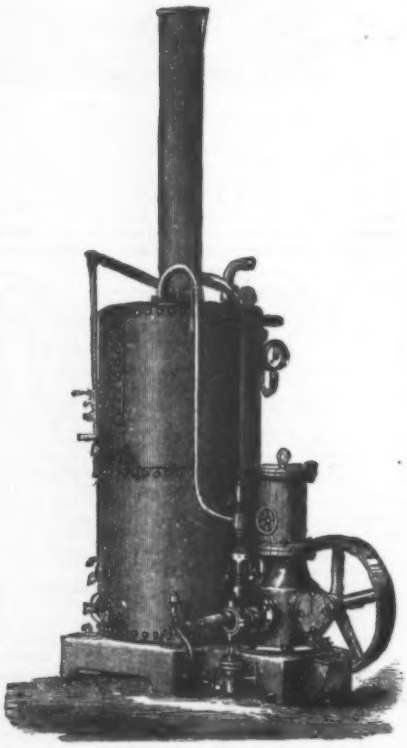


FIG. 2.

Fig. 3 shows a perspective view of the reversing engine with screw propeller attached, as the engine in this form is highly suitable for propelling light craft rapidly through the water, as well as for lifting and winding machinery. Figs. 4 and 5 show vertical sections taken at right angles to one another; Fig. 6, a horizontal section through the piston and slide-valves; and Fig. 7 a plan of the piston end with cover removed. In this variety the steam is admitted, the speed regulated, and the engine reversed entirely by the valve in the top of the piston, views of which are given at Figs. 8 and 9, the former being the under side or face, and the latter the upper side. This valve is turned by means of the square spindle passing through a socket placed in the cylinder cover, and the handle fixed on the latter, so as to afford communication between the port leading to the top of the piston (shown in Fig. 5, and also to the right hand in Fig. 7) and the other two ports alternately, taking steam from one and the other slide-valve (see Fig. 4). The direction of the engine's motion depends upon which one of the two slide-valves gives steam to the top of the cylinder, according to the setting of the reversing valve. Although the square spindle, which is of steel, slides in its socket at each stroke of the piston, it is subject to very little wear from this motion except when being turned for starting, reversing, etc. It is also evident that less labor is required to shift this valve than the ordinary form of reversing gear. The slide-valves are worked by projections on the valve-rod, shown flatwise in Fig. 4 and endwise in Fig. 5; and, as the line of motion is near their face instead of at the back, as in ordinary slide-valves, the valve has no tendency to cant or wear unevenly. If no lead nor lap were required, the lower end of this valve-rod might be made to oscillate simply by means of the crank-pin; but, in order to give the lead and lap, the portion of the crank-pin which actuates the valve-rod is turned so as to be eccentric to the portion

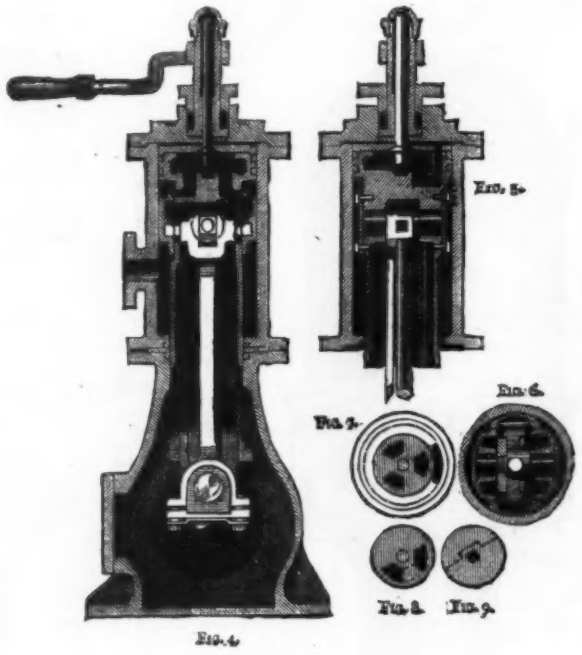


FIG. 4.

FIG. 3.

NEW DOUBLE-ACTION VERTICAL STEAM ENGINES.

rotated by the connecting rod. The motion of the slide-valves is therefore derived from a combined movement of the crank and the eccentricity of that portion of the crank-pin to which the valve-rod is attached, the greater portion of the stroke being performed by the revolution of the crank, while the advance is provided for by the eccentricity of the crank-pin, such eccentricity being equal to the lap and lead of the valve. This will be apparent by an examination of the diagrams at Figs. 10, 11, and 12, showing the different positions of the piston, valves, and crank. The circle *a* represents the path of the crank-pin, or rather that portion of it to which the connecting rod is attached; and circle *b* represents the path of the eccentric portion of the crank-pin on which the valve-rod works. Fig. 10 shows the position of the valves with lead to steam at the commencement of the down stroke; Fig. 11 their position at half stroke when one is full open to steam and the other open to the exhaust, and Fig. 3 their position at the end of the stroke, both giving lead to exhaust.

We said that accessibility of parts is a great feature in these engines. The piston, slide-valves and rods can all be drawn out through the top of the cylinder by removing the cover after both ends have been previously disconnected through the doorway provided for that purpose in the casing opposite the crank-shaft. The bearing brasses of the crank-shaft may also be taken out by removing the glands at the ends, and replaced without disconnecting any other parts. The crank-shaft, reversing spindle, pins, and keys are made of steel, and the bearings, which are all adjustable, of phosphor-bronze or the best gun-metal.

In some existing engines of the encased type a difficulty has been experienced in the excessive wear and tear of the pin on the end of the connecting rod, in consequence of its being placed so far in the piston as to be out of the way of all lubricating matter which might be injected into the cylinder. In the present arrangement of engine this difficulty is obviated by arranging the joint directly opposite the exhaust port formed in the piston, so as to receive the first rush of the exhaust steam with the lubricating matter which it carries. These engines are also so arranged and constructed that any accumulation of water in the cylinders, either from priming or condensation, cannot injure them by straining the crank-shaft or other working parts, nor cause the slightest concussion. As the piston descends, the slide-valve, opening to the exhaust before the end of the stroke, allows any water to escape at once by its own gravity. A large space is also provided under the piston for the slide-valve when at the lowest point in its stroke; and as this space is in constant communication with the boiler, the pressure therein cannot be excessive.

When a reversing engine of this class is required without a flywheel and without dead-point, there must be two cylinders, the sections of which are similar to those of the

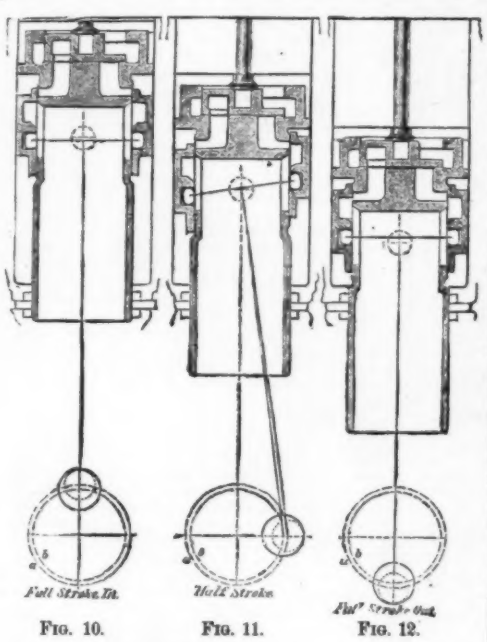


FIG. 10. FIG. 11. FIG. 12.

single-cylinder reversing engine shown at Figs. 4 and 5. At the Liveroool Show a double-cylinder, double-acting, reversing engine of 5 horse-power nominal, weighing only 5 cwt., was exhibited in action. One lever actuated both the reversing spindles together by means of a link, and by its means alone the various operations of starting, stopping, reversing, etc., were performed with the greatest facility.

For large powers this system presents a complete compound engine with one cylinder, the annular space round the trunk taking the place of the high-pressure cylinder, while the larger surface on the upper side of the piston serves for the low-pressure or expansive cylinder, the different areas being proportioned to the pressure of the steam and the degree of expansion desired. In these cases a simple cut-off valve is placed in the steam passage leading from the boiler to the cylinder, the steam being cut off as soon as or before the piston has completed its upward stroke; at this point the slide-valves admit the steam through the piston, which acts by expansion upon the increased area without any further admission from the boiler, the same steam giving by expansion the downward stroke which had before, at a high pressure, performed its upward stroke. A condenser may also be connected with the casing in which the crank revolves and into which the steam is exhausted during the upward stroke. A vacuum would thus be obtained upon the larger area of the piston on the one side, while the high-pressure steam would act upon the smaller area of the opposite side during the upward stroke. Two cylinders can in the same manner be arranged to work two cranks at right angles to each other, on the same shaft, and thus prove equal in every respect to two high and two low-pressure cylinders, dispensing with the first cost and repairs of two complete engines.

The economical working of these engines cannot be doubted, as there is practically no steam wasted by port-space intervening between the cut-off of the valve and the piston surface, as in engines of ordinary construction. This is a point which has been but little considered by engine-builders generally; but that a great waste of steam occurs in filling the ports of the high-pressure cylinders, and also those connecting the high and low-pressure cylinders, is evident on calculating the cubic contents of the ports of a pair of engines of large power running at high speed, a consumption of steam due to the ports alone being, in many cases, equal to the power of several hundred horses. With compound engines on Mr. Turner's system, however, there are really no ports to fill in connection with the high-pressure cylinders, as between that and the expansive or low-pressure piston surface a port only as long as the piston's thickness intervenes. In consequence of that port being so short, and the valves cutting off so close to the piston-surface, the size of the port may be considerably reduced, and also the size and stroke of the slide-valves, thereby effecting a considerable saving not only in steam, owing to diminished port space, but also in reduced friction and in the power necessary to actuate the slide-valve.—*Iron.*

NEW PROCESS MILLING.

IN the endeavor to give an account of the New Process of milling, we are met at the very threshold of the inquiry with an obstacle which baffles all attempts to reduce the main features of the system to a scientific formula. This is due to the fact that the New Process is not so much a distinct system of itself as a series of successful attempts toward a new system. The value of its results can hardly be overestimated; but as yet study and experiment have been unable to lay down rules of universal application and fix the standard of the New Process. This want of definiteness is found in every branch of the new system, and is easily accounted for. The general principles being laid down, such as the granulation of the wheat, the purification and regrinding of the middlings, each miller sets to work to carry them out in his own way. As to the dress and speed of the burrs which are best for the purpose, each miller will have his own ideas, based either upon study, observation or experience; and hence, while there is uniformity in the leading characteristics of the system, in the minutiæ the practice of but few mills is the same. It is the numerous variations of practice among our millers that show that the system is not yet settled immovably, and give the hope of its future perfection; for where so many minds are busily engaged in seeking after the prize in so many different directions, it is impossible that substantial progress should not result.

Almost every mechanical art has been revolutionized by some discovery or invention that changed pre-existing practices; and the New Process marks the revolutionary era in the history of American milling. Though it has been introduced in this country but a few years, it has not only succeeded in enabling American mills to produce a quality of flour unsurpassed by any in the world, but, starting from Minnesota, it has influenced the character of milling in every part of the country, so that even those mills which can hardly be said to be working on the system now turn out a better grade of flour than ever before. Nor has this been the only effect of the New Process. Its introduction into our mills has stimulated invention and improvement in every department of milling, until the mill machinery of our country is unequaled by that of any other nation in the world. Vast merchant mills have been erected in different parts of the country, and the manufacture of flour is now receiving that careful attention which its importance demands.

A system which has accomplished so much, and holds out the inducement of pecuniary gain, certainly deserves the attention of every miller. We hardly deem it necessary to state that the process is not new, in the full acceptation of the term; at least its main features, one and another, have found a place in the milling systems of other countries and other times. It is, however, emphatically a New Process in this country, as its general introduction into our mills dates only a few years back. Up to the beginning of the present century scarcely any appreciable progress had been made over the primitive style of milling. The mills of that time were for the most part exceedingly simple in structure, and their internal arrangements generally comprised a pair of burrs and a single reel. Of course American inventive genius did not allow the whole field of milling to remain untouched; but although mechanical contrivances became greatly improved, the process of manufacture remained the same. The mode of reducing the wheat to flour was by mashing or squeezing, so as to separate the starch and gluten cells as finely as possible. To obtain at one grinding the maximum amount of flour and the minimum of middlings was the universal aim, since the middlings were available only for a low grade of flour; for the purification of middlings was in this country as yet an unknown art. This whole method of procedure has been changed by the adoption of the New Process, which takes as its fundamental axiom that the production of middlings should be as large as possible.

The cardinal principles of the New Process may be briefly stated as,

1st. The granulation of the wheat.

2d. The purification of the middlings (granules) obtained by the first-named operation.

3d. The regrinding of the purified middlings.

None of these principles are new in the history of milling. The granulation of wheat and middlings has long been practiced in Hungary, where it is the foundation of the Hungarian system of milling. In that country it has been a well-known fact for years that by gradual reduction a better quality of flour can be obtained than by any system which reduced the grain to flour by one operation. This knowledge was obtained not so much by study and experiment as supplied by the necessities of the case. Hungarian wheat is of so hard a nature that it would be impossible to obtain good results by subjecting it to the same treatment which softer wheats will bear. With the millstones running close together at a high rate of speed, the bran of the hard Hungarian wheat would be pulverized to a great extent, and so incorporated in the flour that its separation by ordinary means would be impossible. A gradual reduction of the wheat, therefore, became necessary, and the subsequent steps made in perfecting the Hungarian system were the result of the endeavor to utilize the middlings which were unavoidably produced. That this was the case is evidenced by the fact that in the earlier part of the present century a product known as *Wiener gries* (Vienna grits) was sold in several European markets. There are other instances where granulation was first resorted to as a necessity, but wherever it has been introduced the superior flour gained by the system of gradual reduction and purification has always prevented a return to the more primitive style of milling.

But the New Process finds its closest parallel in the *Mouture Economique* or Economical Milling invented at the close of the sixteenth century by Pigeaut, a miller of Senlis, in France, but not put into operation until about 1760 by Malisset, Marin, and the celebrated Buquet. This method of milling consisted in successive regrindings. Rolet thus describes it:

"The first time the wheat passes between the stones, the upper millstone, which is movable, is raised much higher than in subsequent operations, for the reason that it is sought at first, by merely crushing and rubbing the outer coating of the berry, to save the teguments, in order that they may be separated the better in the operation of bolting. After this grinding is accomplished, the first flour is taken out and the coarsest middlings and the bran separated. The middlings are then reground on the stones brought nearer together, and this grinding gives a second white flour and second middlings. These, on being reground, likewise yield a certain quantity of white flour and some middlings. The grinding of the fourth and fifth middlings gives a flour which is called *bise* (our "red dog" or low grade) and offal called *remoulage*, which contain the hard and grayish parts near the coating of the berry. The Lyonnaise milling has since been introduced; so called because the famous miller Buquet introduced it into the city of Lyons. It consisted in regrinding the bran and middlings by a great number of operations. This system was, so to speak, only an exaggeration of the *Mouture Economique*. The advantages which would arise from the employing of the two systems last named were ascertained by the care of the government; and although it has been demonstrated that by their assistance one can obtain a larger quantity of fine flours than by the old systems, they are not yet generally adopted."

It will be seen that the system described above is closely analogous to the New Process, although, on account of the imperfect means of separating and purifying middlings at the command of the millers of that period, a larger number of regrindings were resorted to than are deemed necessary by our New Process millers. In a word, the New Process is a partial practice of the principle of gradual reduction, and as such is merely a modification of the Hungarian system, with such changes as adapt it to the nature of our American wheats and the demands of our American markets.

But the New Process comprehends more than the three principles enumerated above. It is pre-eminently scientific milling, as we shall amply prove in the course of the present series of articles. It means that the wheat must be well cleaned before it goes to the burrs. It not only means that the wheat is ground high, but that it is ground on scientific principles, with burrs as perfect as skill and pains can make them. It not only means that the middlings are purified before regrinding, but that they are to be purified by means of scientifically constructed machines. If the New Process is anything, it is a protest against imperfect methods and imperfect machinery; and it embodies in itself all that is best and most valuable in the mill machinery of the present day. It embraces, in fact, the progressive ideas among American millers, and, being a system of progress, it it necessarily without a fixed standard.—*American Miller.*

NICHOLSON BLUES.

NICHOLSON blue, when applied to wool, sometimes fails. We will, therefore, point out a simple method for avoiding such inconveniences.

The wool is dyed in the ordinary manner in an alkaline beck—that is to say, it is heated to the required shade in a beck containing 1¼ oz. of Nicholson blue and 5¼ ozs. of soda-ash to 11 lbs. of wool.

The blue is then developed, not as commonly done, in a beck containing sulphuric acid, but in a solution of 17¼ ozs. alum and 8¼ ozs. tartar per 11 lbs. of wool.

Wool is sometimes spoiled because the dyer, from injudicious economy, adds the acids to the blue beck instead of keeping the two separate.

Failures sometimes occur from using too much Nicholson blue. It is important to dye in a beck containing exactly the quantity necessary for the required shade, and it is even better to add the color in several portions.

Many dyers are afraid of rendering the blue beck too alkaline, but carbonate of soda (ash) may be safely used up to 17 ozs. per 11 lbs. of wool.

If a greenish blue is required, the color should be raised in a cold sulphuric acid bath containing 8¼ ozs. of acid per 11 lbs. of wool.

Silicate of soda should never be used in place of carbonate. If it is too neutral much hydrated silica is precipitated upon the wool and renders it harsh, while a very alkaline silica causes spots.—*Teinturier Pratique.*

COCHINEAL RED PRINTING ON WOOLENS.

By M. KIELMEYER.

COCHINEAL reds are obtained upon wool in printing by a mixture of a decoction of cochineal, salt of sorrel, salt of tin, oxalic acid, and a thickening; or for decoction of cochineal, or salt of tin, we may substitute a tin lake of cochineal. The acidity of these mixtures gives to the color of the cochineal a yellowish tone, which remains after soaping, or after passage through lime-water, if the pieces are to be steamed. The author remedies this inconvenience by the addition of acetate of soda. In the cold this admixture is without effect, but when heated the acetate of soda acts as an alkali, and loses its acetic acid under the influence of the oxalic acid, which thus becomes neutralized. The color obtained presents a warmer and redder tone; although in appearance less full, in reality it is less brown. If a yellow tone is desired, it is better produced by the addition of a yellow coloring matter than by a change due to the action of a free acid. The author prefers the following formula:

Gum	14 parts.
Water	15 "
Cochineal lake	17½ "
Young fustic lake	2½ "

Heat to 140° Fahr., and when the gum is dissolved add—

Oxalic acid	1 part.
Pure salt of sorrel	1¼ "
Acetate of soda	2½ parts.

After printing, dry at a gentle heat for one or two days, expose for an hour to very hot steam, dry, wash, and dry again. The shade obtained is very like that yielded by a corresponding dye-beck.

The addition of acetate of soda gives much purer tones in steam yellow and oranges with fustic, and especially in magentas upon cottons.—*Dingler.*

DYEING SKINS.

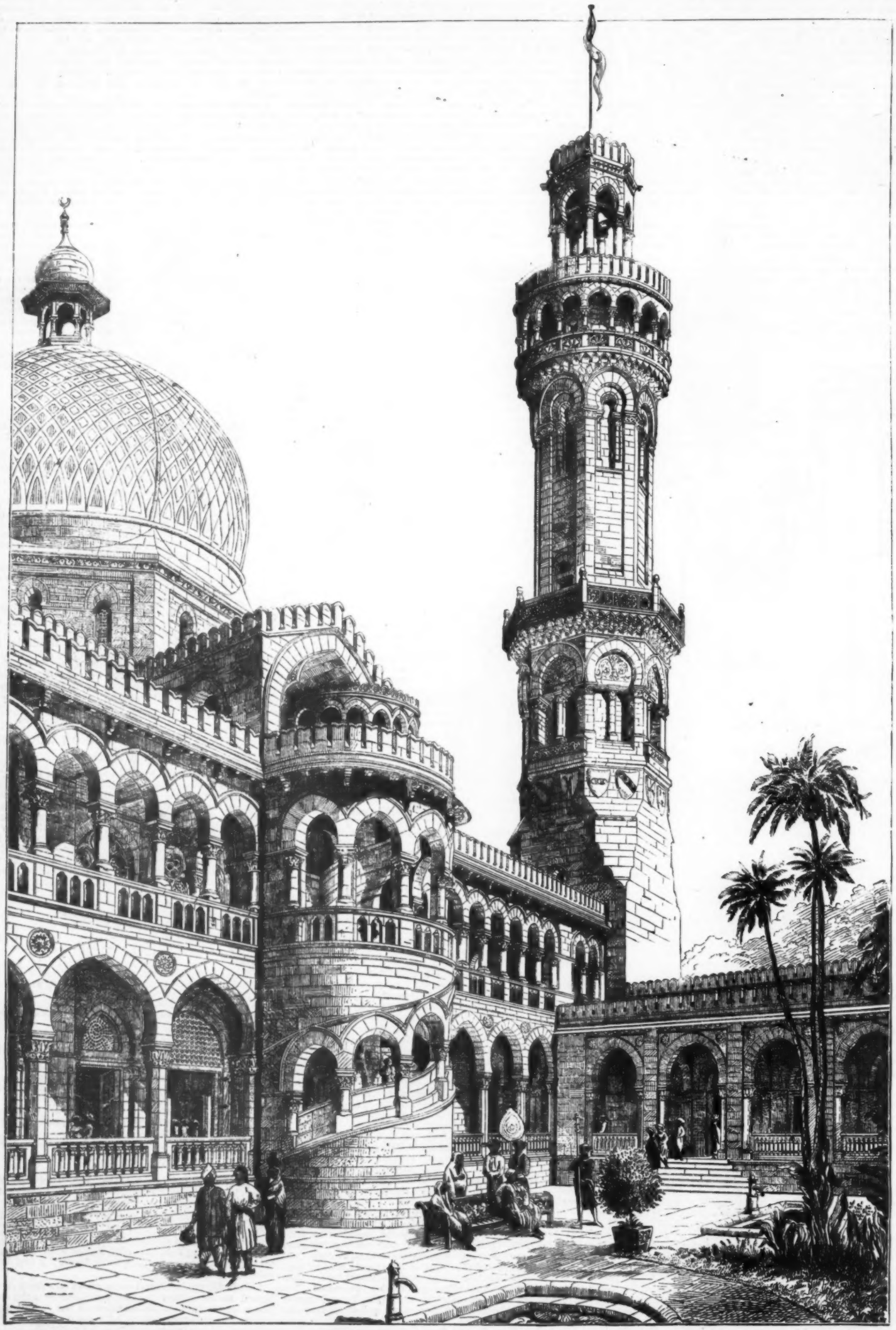
IT has been complained that fine skins dyed with aniline colors lose their proper tint, and, in order to prevent this, Dr. Reimann proposes the three following methods:

1. In two liters of water dissolve 180 grammes of gum arabic, stir the solution well, and rub the dyed skin with it.

2. In two liters of alcohol at 96° dissolve 180 grs. of shellac in a bain-marie; rub the dyed leather with this solution, taking care not to use the same brush for two different colors.

3. Add 120 grs. of liquid ammonia to two liters of water heated to 75° centigrade, and then dissolve in the solution 90 grs. of cassine; stir the mixture till the boiling point is reached; then decant, and with the clarified mixture rub the dry dyed skin as before, and let it dry again.

In order to render the skin supple after dyeing, mix 10 grammes of yolk of egg and 5 grs. of glycerine in a liter of water; rub the skin with this mixture, let it half dry, and then rub it well with a piece of woolen rag only.



THE QUADRANGLE, MUIR COLLEGE, ALLAHABAD UNIVERSITY, INDIA.—*W. Emerson, Architect.*

MUIR COLLEGE, ALLAHABAD.

THE illustration shows one corner of the quadrangle of Muir College, now being erected from the designs of Mr. William Emerson, of Westminster chambers, by the Royal Engineers, under the direction of Col. Fraser, C.B., the Superintendent Engineer of these provinces. This college for the education of the Mohammedans is intended to form part of the University of Allahabad, and is the result of the energetic measures taken by Sir William Muir, K.C.S.I., when Lieut.-Governor of the North-West Provinces, for the higher instruction of the native classes. The building is designed in an admixture of Cairean and Indian Mohammedan styles. At present only two sides of the quadrangle are being built. The large domed building on the left is the convocation hall, named after H.H. the Maharajah of Vizianagram, who contributed £10,000 toward the work. The open stair seen in the view leads to the public gallery. The tower will be 183 ft. high, and contain a peal of bells. The low buildings on the right are the lecture-rooms, with open verandas on either side, which the intense heat necessitates for shade. The stone used in the construction is from Sheorajpore, whitish and nearly as fine grained as marble.—*Building News.*

A CONCRETE BUILDING DWELLING HOUSE.

AT a recent meeting of the Adelaide (South Australia) Philosophical Society, Mr. B. Herschel Babbage read a paper in which he described at considerable length the experiments he had made in the past, and was now making, in the construction of buildings composed of a concrete formed of sand, gravel, common earth, and lime. Among other buildings a very slight building was erected in 1863, which is used for a still-house; it is 11 feet 4 inches long, by 9 feet wide. The arch only rises 12 inches, or one ninth of the span. One side of this building is supported by a cellar wall, the other by a wall 15 inches thick; one-third of the arch is cut away at one end, and a dome of about 8 feet 6 inches external diameter is built partially on the old and partially on the new structure. Though the weight of this dome is about six tons, only one very slight crack has been noticed in the whole structure. Besides buildings, Mr. Babbage has constructed several smaller works, such as cattle-troughs and bridges, all of which answer the purpose for which they were designed.

Mr. Babbage has also constructed an entire house of concrete—walls, roof, staircases all being formed of the same material—of which he says:—

"I have never seen a house of this kind; and I have looked through every page of the volumes of the *Builder* for twenty years back, to see if there is any record of such a building having been made, but can find none. I am justified, therefore, in calling it an experiment, and, I believe that I may add, a successful one. By using Portland cement concrete—that is, concrete in which the lime is replaced by Portland cement—you would undoubtly have a material which would set much sooner than lime concrete; but whether it would at the end of a thousand years be—as lime concrete has been found to be at that age—as hard as or harder than rock, remains yet to be proved, our experience of Portland cement extending over only fifty or sixty years. The great objection, however, to using Portland cement in any quantity in this country is its high price as compared with lime. Even in England, where the price is, I believe, less than one third of its price here, they economize by making the walls very thin, a proceeding which does not suit this climate if a cool dwelling is wished for.

On commencing my new house, I determined to make an experiment that should be adapted to ordinary use by its cheapness. I therefore took no pains to wash the gravel, using it as it came from the creeks in my neighborhood. Undoubtedly, by washing the gravel carefully you can make a better concrete; but where manual labor is so expensive as it is here, the extra time employed in the washing would be a consideration. A good deal of the gravel I used was obtained from a gravel-pit in the neighborhood, and verged upon being too dirty to be used. If I have succeeded with such gravel as this, clean gravel cannot fail to be a success. The style which I have adopted is Venetian Gothic, as one which, while sufficiently ornamental, consorts well with flat roofs, and admits of such irregularities as the necessities of my case required.

The part to the right of the entrance-porch is built upon the site and partly upon the foundations of the old house. It is two stories in height, each story being arched over, the top of the arches of the ground-floor forming the floor of the rooms above; and, again, the arches of the upper floor form a flat-terraced house-top, such as we read of in the Bible and in accounts of Eastern buildings.

Above the top floor is to be an arched corridor, opening into the tower at one end, and facing the terrace roof at the side, so that it will form a pleasant retreat for people to sit in to work or read while enjoying the view and the fresh air, thus utilizing in an agreeable manner a part of the house which is entirely unavailable in houses of the ordinary construction. A few iron rings built into the tops of the buttresses will enable an awning to be spread over part of the terrace as a shade when the sun is too hot.

The arch of the dining-room is 15 feet in width, with a rise of 2 feet 10½ inches, the rise being nearly one-fifth of the span. The side walls were 1 foot 6 inches inside the house, and 1 foot 10 inches outside, with buttresses at the outer angles. The lime concrete at the crown of the arch is 10 inches thick, and at the springing 3 feet 8½ inches. After the centers were removed, and the concrete was thoroughly set, a layer of 2½ inches of Portland cement concrete—one of Portland cement to seven of fine gravel sand—was spread over it; and finally this was covered with a layer of one of cement to one of sand, ½-inch to ¾-inch thick, which was troweled to a smooth face to form the floor of the room above. Thus the finished arch was about one foot one inch thick at the crown, and nearly four feet at the haunches. The weight of this arch is about 32½ tons now that it is thoroughly dry, reckoning 1·4 of a ton to the cubic yard. This is about the weight given in architectural text-books, and corresponds with the result of an experiment which I made myself.

The weight of the arch of the morning-room is about 23½ tons. The floor of the dining-room is made of 5 inches of lime concrete, with cement concrete and facing above it of the same thickness as those upon the arch. The floor rests upon 18 inches of made earth, it being raised above the natural surface of the ground; and the consequence is that some slight cracks have taken place in the floor owing to its settlement. No cracks are to be seen either in the floor of the room above or on the arch forming the roof of the top room.

The weight of the arch of the bedroom above the dining-room is 27 tons, the bow window being confined to the lower story. The wooden centers, upon which the lower arch was built, were left for eleven weeks before being removed, as it is a large arch, and I did not like to risk a settlement; but I am convinced that they might have been removed sooner if it had been wanted. The arch above was not commenced until six months afterward. As the ribs of the centers are formed with 1¼-inch flooring boards, cut to the sweep of the arch, roughly nailed together with ties and struts 1½ inch thick, the chief dependence for supporting the arches during the building is placed upon a considerable number of uprights and raking struts resting upon the arch of the floor below. Thus the whole weight of the upper arch when the concrete was wet (which must have been upward of 35 tons) was borne by struts resting entirely upon the lower arch; so that the new arch (nine months old) had to undergo a test very much greater than any weight that could ever be put upon it in its use as a habitation.

All the arches of the ground floor had to undergo a similar ordeal during the construction of the arches above. In two cases I have had a slight settlement take place while the concrete of the arch was quite soft, owing to imperfect strutting; and in a third case I was taking down the centers during very wet weather—three weeks after the arch had been built—when we discovered a settlement of the arch beginning to take place from the concrete not being sufficiently set, and we had to put the centers up again. The result was that after leaving the centers up about two weeks longer, when we took them down we discovered a flaw in the crown of the arch. It was the arch over the morning-room, of 11 feet 9 inches span. As the simplest way of remedying this, I cut a hole right through the arch where it was defective—being about a square yard—and left the edges of the hole sloping like a keystone; then put up the centers again, and filled in the hole with fresh concrete.

All these arches in due time had their cement covering put upon them, which would at once have shown by its cracking if any fresh settlement whatever had taken place. I have now built in this house upward of sixteen arches of varying size, from 6 feet square to 21 feet by 16 feet 6 inches; and in no one case has any settlement whatsoever shown itself since they had their cement covering put upon them.

The only failures—if they can be called so—that I have met with were, on one occasion, the giving way of a barrel-arch 4 feet span, forming a flight of steps, owing to one of the principal props breaking in half and causing the fall of the centering and the wet concrete put upon it; and upon another occasion when a horse mistaking the house-door for a stable-door came in upon a new arch, the concrete of which was yet green, when one of its hind legs broke the crown of the arch and went down through it. This damage was, of course, easily repaired by cutting the breakage out as described in the account of the preceding arch, and putting in a new wedged-shaped mass of concrete.

There is a small inner hall, showing a gallery round it, level with the floor of the bedrooms, to give access to them. This gallery is arched over at top. The arches I have described above are barrel-arches extending the length of the rooms, and having a flat Gothic arch. The ground and upper floors of this inner hall are built differently, as the arched ceilings rise from all four sides, so that the arches intersect each other in the angles, forming groins, and would meet in a point at the center if carried out entirely; but an octagonal aperture is cut in the top, thus forming the gallery before mentioned. The upper part of the hall above this gallery is also arched over in a similar manner, but an octagon is cut out of it, upon the margin of which is built a dome, 6 feet 6 inches in diameter inside, 9 feet outside, which, including the drum, is 8 feet high inside. The whole weight of this drum and dome, amounting to 21 tons, rests upon the edge of the octagonal opening.

The first flight of stairs in my new building consists of a flying arch, the bottom resting upon the top of the arched landing over the stairs below, and the upper end abutting nearly at right angles against the wall of the staircase. Upon the upper surface of this flying arch the steps are cut out, or rather moulded, when the arch is made. In building this arch, channels or holes were cut in the face of the side walls against which it rests, so that the concrete of the arch might unite with that of the side wall.

Whenever, from any cause during the building, it became necessary to put new concrete against the face of the old work, channels were cut here and there in the old face, to form a better junction between them. After the concrete steps were well set, they were covered with a layer of two inches of fine cement concrete, and finished over with half an inch of fine cement, consisting of one of cement to one of sand; like the floor, the nosing of the steps was formed in the cement concrete by the help of wooden moulds. The surface of concrete walls is well adapted for receiving plaster, as it offers a good natural key for it, and the plaster incorporates itself with the concrete, forming a solid body.

For plastering my house, both externally and internally, I use a mortar to which a small quantity of sugar has been added. The mixture I adopt consists of fourteen bushels of sand, four bushels of unslaked lime, and twelve pounds of the coarsest and cheapest sugar I can get. I generally mix these quantities at one time in a 'bay.' The sand is put round in a ring, the lime, slaked and riddled, is put inside in the usual manner, and the twelve pounds of sugar dissolved in a small quantity of hot water poured over it, and the whole well mixed together.

The original recipe was obtained from Algiers by Col. Robe, a former governor of this colony, but there was some mistake in the proportions given in it. Those I have given above are the result of a number of experiments that I have made myself. This mortar sets quicker than common mortar, has more adhesive power, and is very much harder; it has, besides, the additional recommendation of being partially waterproof. I have used for lining baths, small tanks, etc., a mortar mixed in the proportion of 1½ sand to one of lime, with ¼ pound of sugar added to each gallon of the mixture, and found it quite waterproof. The theory of it I take to be that the sugar combines with the lime, and forms a saccharide of lime, which is only sparingly soluble in water.

The string-course, cornice, and mouldings over the windows are made in concrete by applying wooden moulds of the requisite forms to the place where these ornaments are to be put, and filling these moulds with concrete. I find that by lining the moulds with damped paper I obtain a better surface, and that it is easier to detach the moulds. For the outer surface of the mouldings I use 'sugar-cement concrete' made of four bushels of fine gravel, one bushel of lime, and six pounds of sugar. The moulds are lined with this fine concrete, and then backed up with the ordinary concrete, so that the mouldings form a solid projection of the substance of the wall itself."

Mr. Babbage's paper was illustrated by a number of diagrams.

In answer to questions, Mr. Babbage said that he considered the cost of concrete under ordinary circumstances would be 25 per cent less than stone or brickwork, and even with that decrease in cost much thicker walls might be constructed, which was a great consideration in the climate of Australia. His house was cooler in summer and warmer in winter than most houses.—*The Builder.*

GAS ANALYSIS.

AT the recent meeting of the American Gas Light Association, Cincinnati, Mr. Goodwin explained his new method and instruments as follows, as reported in the *American Gas Light Journal*:—

In the destructive distillation of coal the following gases are produced: Ammonia (NH_3); Sulphureted Hydrogen (SH_2); Carbonic Acid (CO_2); Air or Oxygen and Nitrogen; Bisulphide of Carbon (CS_2); Olefiant Gas (C_2H_4); Acetylene, etc. (C_2H_2); Carbonic Oxide (CO); Light Carbureted Hydrogen (CH_4); Hydrogen (H).

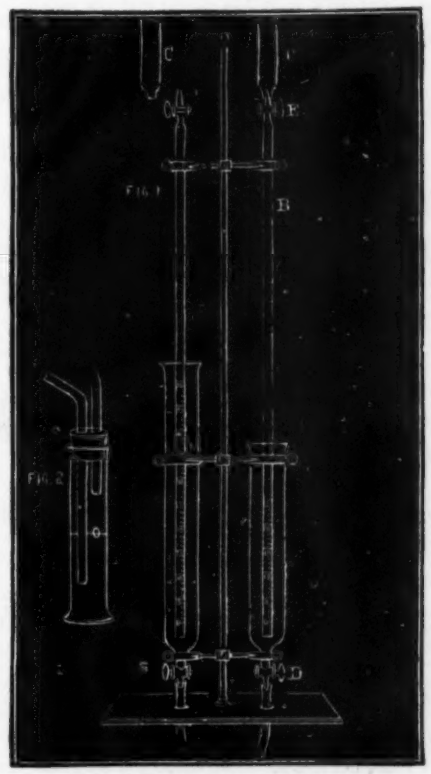
The first four of these gases on the list, although often present in well made gas, are generally considered impurities, and by right should not be there.

The apparatus will determine the presence of the above gases and their quantity.

The re agents used in this method are: 1. Dilute Sulphuric Acid. 2. Solution Nitrate Silver. 3. Solution Arsenious Acid. 4. Solution Iodine. 5. Bromine. 6. Solution Caustic Potassa. 7. Solution Pyrogallate Potassa. 8. Solution Sub-Chloride Copper in Hydrochloric Acid. 9. Lime Water. 10. Red Litmus Water. 11. Solution Acetate Lead.

In order to make an analysis of coal gas by this method, we must first make what is known as a qualitative analysis, that is, determine the presence of certain gases; this will decide the order of precedence in their removal.

For this purpose we use apparatus No. 2, which is so constructed as to admit the gas to be bubbled through any liquid we may place in it. Thus if the gas is suspected to contain ammonia (NH_3), we fill the apparatus (to say the O line) with a solution of red litmus, and allow the gas to pass through the liquid for several minutes; if ammonia (NH_3) be present, the red litmus will turn blue.



GOODWIN'S GAS ANALYSIS.

If carbonic acid (CO_2) be suspected, we fill to O line the same apparatus (after washing) with lime water, then pass the gas; if a white precipitate is formed, carbonic acid (CO_2) is present.

For detecting sulphureted hydrogen (SH_2), we carefully cleanse the apparatus, and fill to the O line with a solution of acetate of lead; now pass the gas. If in a short time the liquid turns brown or black, the presence of this gas (SH_2) is shown. Carbonic acid (CO_2) will give with this solution a white precipitate, but if sulphureted hydrogen (SH_2) be present also, the white will turn brown or black.

Having determined the presence or absence of these gases, we are now ready to use the second apparatus for determining the per cent. of these and other gases.

Place the apparatus, Fig. 1, as shown in drawing; fill the funnel A with water that has been standing in the room until it has acquired the same temperature; we now adjust a flexible tube upon the tip of eudiometer B, open the stop-cock E, and by exhaustion fill the tube with water from the funnel A; when full, close stop-cock E, and remove flexible tube, which is now placed upon a jet and the gas to be examined is allowed to pass through it for a minute or two. While it is thus passing freely we place it on the tip of the eudiometer; by opening the stop-cock E the water will flow out and the gas will take its place. By opening the stop-cock D of funnel A the water will be drawn off until the gas fills the tube to the O point, when the stop-cock D of funnel A, also the stop-cock E of tube B, are closed.

Now place the funnel C upon the tip, which completes the first part of the operation.

If in our qualitative examination we have found ammonia (NH_3) and sulphureted hydrogen (SH_2), we proceed to determine the per cent. of ammonia (NH_3). For that purpose we introduce about ½-ounce of *dilute* sulphuric acid in the funnel C and gradually open the stop-cock E and allow it to flow down the tube, always leaving a little of the liquid in the funnel to prevent the introduction of air. A few minutes will be required for the liquid to subside, and the rise

of the water in the tube will indicate the per cent., when we have drawn off the water in funnel A to the same level as the liquid in the tube B; this must always be done at each reading of the different gases.

It is also well to place in funnel C a little pure water to cleanse it after each re-agent.

A better solvent for ammonia (NH_3) is a solution of nitrate of silver mixed with a solution of arsenious acid in equal quantities; this cannot be used if sulpureted hydrogen (SH_2) be present.

For sulphureted hydrogen (SH_2) we place in the funnel C a solution of arsenious acid, and allow it to flow down; the rise of the water in the tube will indicate the per cent. of this gas (SH_2).

When we find ammonia (NH_3) we do not find carbonic acid (CO_2), and *vice versa*. So if our qualitative examination shows carbonic acid (CO_2) we commence our quantitative analysis for this gas instead of for ammonia (NH_3). Its well-known solvent is a dilute solution of caustic potassa; about one-half oz. will be sufficient to place in the funnel C; when passed down the tube it causes a rapid absorption, and the rise of the water shows the per cent.

For bisulphide of carbon (CS_2) one-half ounce of solution of iodine in water is placed in funnel C and carefully allowed to flow down. The rise of water gives the per cent. (CS_2).

We next absorb the illuminating gases, which, in all probability, will be a mixture of olefiant gas (C_2H_4), acetylene (C_2H_2), per-carbide of hydrogen, and the vapor of benzole. These are all acted upon and dissolved by bromine; to use this very heavy liquid, we first place in funnel C one-half ounce of water, and for coal gas two or three drops of bromine (for naphtha gas ten to fifteen will be required), and very carefully allow the bromine to flow down. It will fill the tube with a red vapor, if we have added enough, and will cause an expansion of the gas in the tube instead of contraction. After a few minutes we place in funnel C one-half ounce of solution of caustic potassa with the vapor already there, and allow it to flow down; this will absorb the red vapor, and the rise of water in the tube will give the per cent. of illuminants.

For air, use one-half ounce of pyrogallate of potassa, and wash down with water; the rise will give per cent. of oxygen (O); and as oxygen is one-fifth of the air, we say four times the per cent. observed is nitrogen (N), or five times the per cent. observed is air, and so record it.

For carbonic oxide (CO), use half an ounce sub-chloride copper in hydrochloric acid; this absorbs this gas, but before reading the per cent. wash with water, and after the water a little caustic potassa is allowed to flow down; the rise of the water gives the per cent.

The remaining gas in the tube is a mixture of hydrogen (H) and light carbureted hydrogen (CH_4) plus the nitrogen (N), and will be so recorded. It is seldom necessary to make a separation of these gases, for they both serve to dilute and carry the illuminating gases. In coal gas they are about equal in quantity.

This completes our analysis, and if the temperature of the room and all the re-agents used have been the same, and we have been careful not to handle the tube with our warm hands, the readings will be approximately correct.

It is well to have a second tube, as shown, filled the same as the one we use, to note any change of temperature.

It is important that the order here recorded be carefully observed.

[From the CHEMICAL NEWS.]

PROCEEDINGS OF THE CHEMICAL SOCIETY, LONDON, DECEMBER 6th, 1877.

DR. J. H. GLADSTONE, F. R. S., President, in the Chair.

GALLIUM—THE NEW METAL.

GALLIUM was discovered by Boisbaudran, August 27 to 29, 1875. It was first obtained in the metallic state in November, 1875. Spectrum consists of two bands in the violet; one brilliant, of wave-length 417, and a feeble band of wave-length 403·3. It was extracted in the first instance from zinc-blende of Pierrefitte, a mine in the Pyrenees, afterward from a black blende of Bensburg on the Rhine. The latter contains 1 part in 100,000; the former 1 in 400,000; 0·65 grm. of gallium being obtained from 430 kilogrms. of Pierrefitte blende. In appearance it resembles lead, but is less blue, tarnishes slightly on exposure to moist air; it is slightly harder than lead, flexible, malleable, and can be cut with a knife. It is not appreciably volatile at a red heat, and is but slightly attacked by oxygen at that temperature. Its specific gravity is 5·9; when fused, 6·08. It melts at 30·15° C., presenting a brilliantly white appearance. When once fused it remains liquid, even for several months, at 0° C., but is immediately solidified when in this condition by contact with solid gallium. In consequence of this curious phenomenon of surfusion, the element was at first described as a liquid metal. Crystallizes in square octahedra. In properties it is more or less intermediate between aluminium and indium. The solutions of its salts give the following reactions: With ammonia, a white gelatinous precipitate, soluble, but not freely, in excess; potash, a similar precipitate, soluble in excess. Acetate of ammonia, on boiling in a solution free from excess of acid, precipitates a basic compound. Carbonate of baryta easily precipitates the salts of gallium in the cold. The salts already prepared are the sulphate, which is very soluble, but not deliquescent; the chloride, very soluble and very deliquescent, decomposed by a large excess of water, and the alum. A solution of the latter, on heating, deposits a basic sulphate, which goes up again on cooling.

Mr. Fisher stated that no satisfactory detefminations of the atomic weight or specific heat of the new metal had yet been made, and pointed out that the small quantity (0·65 grm.) had prevented M. Boisbaudran from fully investigating some other reactions. Specimens of the metal and the alum were exhibited.

"*Nitrification*," by R. Warington. The author states that it has been generally assumed, when nitrogenous organic bodies decay in a porous medium offering a sufficiently large surface for oxidation, that nitrates must necessarily be formed. This view has, however, never been confirmed by exact experiments. In February last Schlœsing and Müntz (*Comptes Rendus*, lxxxiv., 301) laid before the French Academy a paper proving, in their opinion, that nitrification was due to the action of an organized ferment. Their fundamental experiment is the following: A glass tube, 1 meter long, was filled with a mixture of 5 kilos. of ignited sand and 100 grms. of powdered limestone. Through this mixture a slow stream of sewage filtered, so that it occupied eight days in passing down the tube. During the first twenty days no nitrates appeared in the exit-tube: after this period they could be detected. Their quantity rapidly increased, until no ammonia could be found in the exit water: this continued for four months. A small vessel of chloroform was now placed on the top of the tube, so that the vapor passed down through the soil. (This re-agent effectually suspends the action of organized ferments, while it has but little effect on soluble ferments (*Comptes Rendus*, lxxx., 1250). In ten days all nitrates disappeared, and the ammonia salts passed through unchanged. After fifteen days the chloroform was withdrawn, but no nitrification took place during seven weeks. 10 grms. of a soil which was known to nitrify were now treated with water, and the washings poured on the column of sand so as, if possible, to seed the soil anew. Eight days after nitrates again appeared as before. The importance of this new theory is clearly very great, so the author has tested it by further experiments in two distinct lines of proof. First, the action of antiseptic vapors in preventing nitrification: Four tubes were filled with moist kitchen-garden soil. Through the first moist ammonia-free air was drawn by an aspirator. Through the second air moist as before, but previously passed through a bottle containing sponge moistened with carbolic acid. The air drawn through the third tube was similarly charged with a little bisulphide of carbon; that through the fourth with chloroform. Two series of experiments were made. At the end of the experiments the nitrates formed in the soil were determined by the method of Crum and Frankland: the results are given in the following table, the experiments lasting 39 and 46 days respectively:

Nitrogen as Nitrates and Nitrites per Million of Air-dried Soil.

History of Soil.	First Experiment.	Second Experiment.
Original soil	6·12	8·91
Air passed	40·87	50·86
" with carbolic acid	17·20	40·77
" with carbon bisulphide	6·70	9·75
" with chloroform	9·48	7·86

The result of these experiments proves that chloroform and bisulphide of carbon effectually prevent nitrification; that carbolic acid is probably effective to the extent in which it comes in contact with the soil. So antiseptics, as a class, are inimical to nitrification. The second line of proof investigated was the possibility of inducing nitrification by seeding with a substance already nitrifying. After several unsuccessful attempts the author succeeded in nitrifying practically the whole of an ammonium salt. Four stoppered pint bottles were taken, and nearly filled with a solution of ammoniac chloride (1 c.c.=0·000025 grm. ammonia), to which a small quantity of acid phosphate of potassium was added. Two of the bottles were seeded with about 1 grm. of surface-soil from a "fairy ring." One unseeded and one seeded bottle were kept in the light, the other two in the dark. In three months' time the seeded bottle in the dark contained abundance of nitric acid and no ammonia; the other three contained plenty of ammonia but no nitric acid. 1 c.c. of the liquid which had undergone nitrification was now added to each of the unseeded bottles, one in the light and one in the dark. 0·005 grm. of acid tartrate of potassium (to supply organic carbon) was also added to each bottle. In a month the bottle in the dark contained abundance of nitric acid; the one in the light was unnitrified. The conclusions of Schlœsing and Müntz have thus been completely confirmed, with the addition of the important fact that darkness is apparently essential to the action of the nitrifying germs.

After the thanks of the meeting had been given to the author for his important communication—

Dr. Gilbert said that it now seemed strange, having the parallel of the acetic acid fermentation, that this important process had remained so long uninvestigated. In his opinion, the experiment of Schlœsing and Warington left no doubt as to the correctness of their explanation of the process. Dr. Gilbert then drew attention to the great variety which has been found to exist in the power possessed by soils and plants to nitrify in different degrees. Thus one soil would nitrify four to five times as much as another under similar conditions.

Mr. Howard said that the value of old niter-beds as compared with new ones had long been appreciated, but not understood. The paper of Mr. Warington afforded a satisfactory explanation of their value. He would like to ask if any substances, such as spongy platinum, besides the ferment, possessed the power of nitrification.

Mr. Tidy did not quite understand the relative action of light and darkness on the process, as the bottles exposed to the light were for such a long time—*i. e.*, during the night—in darkness.

Mr. Kingzett inquired whether the presence of oxygen was necessary.

Dr. Frankland could but express his admiration of the paper. The subject was one of the greatest importance. He would suggest that some experiments should be made to try and assist the action of these industrious, inoffensive mycoderms. For instance, an acre of soil 6 feet deep will dispose of the sewage of 3,000 people; it would be very desirable to increase this nitrifying power five or even a hundredfold, and in his opinion it was quite probable that the rate might be much increased.

Mr. Hartley thought that the strongest evidence of the presence of an organism was the fact that the process would not go on without the presence of organic carbon.

Dr. Armstrong pointed out that all known instances of the action of unorganized ferments could be resolved into simple effects of hydration; in every case there was a splitting up of a complex molecule. With organized ferments, however, a complication in structure was often produced. The absence of nitrification in the bottles exposed to light might be due to the presence of chlorophyl containing organisms.

Mr. Warington, in reply, stated that it was by no means asserted that nitrification could not take place without an organism, but that for the process to go on in soil in this rapid way the presence of the organism was requisite. In answer to Mr. Tidy, he could throw no light on the fact that darkness was necessary for the process. No attempt had been made to specially aerate the liquids in the bottles. He would not like to say, without further experiment, that the presence of organic carbon was essential for nitrification, but from analogy he should conclude that it would be necessary.

"*On Potable Waters*," by E. J. Mills, D. Sc. After a consideration of the processes for determining the organic constituents of water, the author concludes that the process of Frankland and Armstrong must form the philosophical starting-point in an endeavor to solve the problems of water analysis, and refers to it exclusively throughout his paper. He first considers, in an elaborate manner, the errors incidental to this process, and compares them with those found in Gmelin in determinations brought forward as evidence of the composition of various bodies, and finds that the accuracy of the process compares favorably with that of the ordinary combustion process, and may be safely used as a basis of inference. As regards errors, the author discriminates, in blank experiments (*a*), the chemical error due to the introduction of sulphites, and (*b*) the volume error from the addition of *n* cubic centimeters of purified water. The size of the dish used to evaporate the water has a perceptible effect. Thus, with a 3-inch dish, the organic carbon =0·323; organic nitrogen =0·024. With a 6-inch dish, C=0·307, N=0·034, the carbon diminishing and the nitrogen increasing with the size of the dish. The author then describes a new evaporator, which consists of a cylindrical copper water-bath, with a hemispherical copper cover cooled by a flow of water. The water is contained in a 3-inch glass dish underneath the cover, and is supplied by a constant convectionless feed. A stream of purified heated air is drawn across the top of the glass dish by an aspirator. In an hour, with a current of 1,062 liters, 100 c.c. will be evaporated. From a consideration of the analysis in the "Sixth Report of the Rivers' Commission" the author has arrived at three natural constants or ratios of organic carbon to organic nitrogen in potable waters—(*α*) 3·067, $C_{12}+N_5$—3·429; (*β*) 2·521, $C_{12}+N_6$—3·571; (*γ*) 2·056, $C_{12}+N_7$—2·057. In conclusion, the author makes some interesting suggestions as to the origin of the constancy of the composition of the air, the effect of an alteration in the mass of atmospheric oxygen, etc.

"*Derivatives of Allylaceton*," by J. R. Crow. The aceton was prepared according to Zeidler's method, diluted with an equal volume of ether, and transferred to a flask surrounded by cold water, and containing a volume of water twice as great as the ethereal solution. The flask was connected with a reversed condenser, and an excess of sodium gradually added. The ethereal solution was separated and distilled, after drying with potassium carbonate. After the ether had distilled over, the remaining liquid came over chiefly at 135° to 140°. After repeated fractional distillations it yielded the pure substance, boiling at 138° to 139°, having the composition $C_6H_{12}O$; sp. gr. 1·842 at 16·2. It appears to be a secondary alcohol and a homologue of allyl-alcohol. Its acetate was prepared as a colorless liquid boiling at 147° to 149°. A dibromide was also formed by the action of bromine as a slightly brown thick mass, which did not crystallize: it has the composition $C_6H_{12}Br_2O$.

"*Method for Estimating Bismuth Volumetrically*," by M. M. P. Muir. It has been shown by Sonchay and Lenssen (*Ann. Chem. Pharm.*, cv., 245) that a normal bismuth oxalate on boiling splits up into a basic oxalate of the composition $Bi_2O_3 2C_2O_3$+aq, but slightly soluble in nitric acid. The author has utilized this reaction for estimating bismuth. An excess of saturated solution of oxalic acid is added to the solution containing bismuth, the precipitate allowed to settle, the supernatant liquid poured off, and the precipitate boiled with water until free from acid. The residue is now dissolved in dilute hydrochloric acid, and titrated with permanganate. The absence of free hydrochloric acid must be secured before precipitating. The results are accurate, and the method is generally applicable.

"*The Gas of the Grotto del Cane*," by T. G. Young. The author has analyzed the gas, which contains 61·5 to 71·0 per cent. of carbonic acid, the residual air having the composition—oxygen 20·25, nitrogen 79·75. Finot states that in the residual air there is more oxygen than in ordinary atmospheric air. The author cannot confirm this statement. The temperature of the cave in some places is as high as 40°.

"*Tetrabromide of Tin*," by T. Carnelly, D. Sc., and L. T. O'Shea. A piece of combustion-tubing was bent in the shape of the capitals V and W joined together. In the middle bend some tin was kept melted. Bromine was dropped from a tap-funnel into one of the other bends. The metal burns in the bromine-vapor, and the tin bromide condenses in the third bend. By distillation the body was obtained pure as a colorless liquid, solidifying to a mass of colorless crystals. Melts at 30° C.; boils without decomposition at 201°; does not fume, and is very slowly decomposed in air; dissolves in cold water without immediate decomposition. It gave, on analysis—Sn 27·11, Br 72·78. Its vapor-density was found to be 229.

LIQUEFACTION OF THE BINOXIDE OF NITROGEN.

By M. CAILLETET.

THE author has succeeded in liquefying this gas by the pressure of 104 atmospheres at —11°. At +8° the binoxide remains gaseous at a pressure of 270 atmospheres. Pure formen compressed by 180 atmospheres at 7° (+ or — ?) gives rise, when the pressure is suddenly reduced, to a mist, like that which appears when the pressure upon liquid carbonic acid is suddenly diminished. This fact gives the author hopes of effecting the liquefaction of formen. M. Berthelot, in presenting the above communication, called attention to the discovery of Mr. Andrews, that there exists for every vapor a critical point of temperature, above which liquefaction cannot be produced by any pressure soever. This critical point, for the binoxide of nitrogen, appears to lie between +8° and —11°.

IRON-CYANOGEN COMPOUNDS.

By DR. Z. H. SKRAUP.

THE author describes super ferrid-cyan-potassium ($Fe_2Cy_6K_3$), identical with Bong's black prussiate, and obtained by the action of potassium chlorate and hydrochloric acid upon potassium ferrid cyanide. If heated with nitric acid it is converted into potassium nitro-prusside. With the salts of barium, strontium, calcium, and aluminium solutions of super-ferrid-cyan-potassium give no precipitates; neutral salts of lead give no precipitate, but take a peculiar blue color; sugar of lead gives an abundant green precipitate, resembling hydrated chromic oxide; silver nitrate produces a dirty green precipitation, which turns yellow on standing, more rapidly if boiled, and finally turns white, but very slowly; copper and nickel are precipitated olive-green; cadmium and manganese, a gray violet; zinc, a grayish blue; cobalt, a red-brown. Ferric salts give no precipitate, but merely an olive-green color; ferrous salts produce a characteristic blue-green precipitate. The super-ferrid-cyan-potassium can only be obtained pure in an amorphous condition. Bong's crystallized black prussiate was probably contaminated with potassium sulphate.

HYDROCARBONS PRODUCED BY ACIDS UPON CAST-IRON.

By M. S. CLOEZ.

THE treatment of a white cast-iron containing 0·04 of combined carbon, and about 0·06 of manganese, with hydrochloric acid of sp. gr. 1·12, occasions the formation of gaseous and liquid hydrocarbons, homologues of ethylen, absorbable in bromine, and capable of combining readily with hydrochloric acid. There are also produced formenic compounds insoluble in and not attacked by sulphuric acid. To prevent the ethylenic carbides from combining with hydrochloric acid it is best to treat the cast-iron with sulphuric acid, mixing 1 part of acid at 66° B. with 5 parts of water. A gentle heat may be applied to promote the action. On treating in this manner 200 kilos. of cast-iron the author obtained 640 grms. of oily carbides, condensed in the first washing-bottles; 2,780 grms. of bromated ethylenic products; 532 grms. of formenic hydrocarbides isolated by the action of sulphuric acid; 3,800 grms. of insoluble residue, supposed to be dry; and, lastly, 408 grms. of oily products extracted from the insoluble residue by alcohol, and separated from the latter by water. The formenic hydrocarbides, which the author describes in the present paper, after purification were submitted to fractionated distillation. The first products went over at 155°, and the temperature rose rapidly to 160°, where it remained for a time stationary. All that passed over below 170° was kept separate, as also the portion volatilized between 175° and 190°, and thus from 20° to beyond 300°. By repeated and delicate fractionations seven distinct products were obtained, with constant boiling-points, and with corresponding chemical and physical properties. All these products are already known, and appear identical with some of those extracted from the petroleum oils by MM. Pelouze and Cahours. They are the highest terms of the formenic series. The first hydrocarbide is the hydride of decyle, $C_{20}H_{22}$, boiling between 155° and 160°. The second, found in small quantity, is the hydride of undecyl, $C_{22}H_{24}$, boiling between 178° and 180°. The remainder are the hydrides of duodecyl, of tri-decyl, of penta-decyl, and of hexa-decyl. The identity of these complex carbides, obtained by the reaction of mineral compounds without the intervention of any life, supports the opinion of certain geologists relative to the origin of the petroleum oils. From a purely chemical point of view, with reference to the synthesis of so-called organic bodies, the reproduction of a great number of these species may be effected from setting out from the ethylenic or formenic hydrocarbides yielded by cast-iron.

THE BURLING PROCESSES OF FREZON AND JOLY.

By J. DELONG.

WHEN the destruction of the burls is effected by means of muriate of alumina, the vegetable matter is scarcely changed in color, but it is broken up on the application of friction or pressure, and, what is a remarkable fact, the hardest substances are the most readily attacked—first straws, then hemp, linen, and cotton; thus experiments made by regulating the temperature and the time of the exposure of the goods in the stove lead us to believe that it may be possible, on an industrial scale, to remove foreign vegetable matters without touching the cotton.

Two objections have been made to the "Joly" system (the use of muriate of alumina), which it is well to discuss here.

It has been said that white goods, burled by Joly's process, are not sufficiently white to be sent to market in that state. This was formerly true, but is now no longer the case, and this is the explanation:

At Albeuf so few white goods are intended to be sold in that state that M. Joly had probably not turned his attention to this detail, but having sold his process to Bellot, Dourne & Co., of Reims, this defect has been there examined, and made to disappear.

In Joly's process, as well as in the acid process, the wool or the woolen stuffs are exposed for a certain time to a temperature of 212° to 248° Fahr., but at this heat white wool turns slightly yellow. This is no inconvenience for pieces which are to be dyed, but it is, of course, injurious for such as have to be kept and sold as whites. To obviate this evil the heat of the stove has been reduced, and the pieces are left in it for a longer time. White pieces burled by Joly's process and exposed to a maximum temperature of 194° Fah. were found perfectly freed from vegetable matter, and were at the same time of a dazzling whiteness.

As for the second fault, if well founded, it would be quite as applicable to the system of Frézon as to that of Joly. It refers to a difficulty which may be encountered in fulling.

This may happen in consequence of defective washing after burling. It is evident that, if the goods are not perfectly cleansed, there will remain a hydrate of alumina, which will combine with the soap, rendering it insoluble, and remaining as an inert and very injurious matter, not easy to remove. But we must never forget that if the washing is thoroughly performed this accident need not be feared: on the contrary, certain manufacturers, among whom may be mentioned M. Bertrand de Louviers, profess that they can perform the fulling process more quickly and easily with burled cloths than with such as have not undergone the operation.

The action of acids upon vegetable matters is well known; but what is the action of the muriate of alumina in Joly's system of burling?

The chemical experts, Salvetat and Barral, have justly remarked that the muriate of alumina has no relation with the acids, whether vegetable or mineral; that burling with this salt can only be ascribed to a specific property quite independent of the influence which the muriatic acid would exert if employed in the free state, and completely unknown till it was discovered and applied by Joly.

This answer establishes the difference between the acids and muriate of alumina as it may be traced in their effects.

If the goods on coming from the stove are left in a moist place for a day, the vegetable impurities are no longer capable of being broken up by friction or pressure.—*Le Jacquard.*

ULTRAMARINES.

By E. GUINOT.

ON following the successive phases of the furnacing of ultramarine, as generally prepared at present, we observe various colors, which succeed each other in the following order: brown, green, blue violet, red, white. These colors are the result of the progressive oxidation of the original mixture of materials. When the furnace containing the crucibles reaches a red heat the sulphur melts and produces immediately polysulphides with the sodium. The compounds thus formed present various colors, but they are so unstable in presence of air and water that they cannot be defined. They appear to owe their coloration exclusively to the sulphides which saturate the mass. The first stable product is the brown; it appears at the moment when, as the fire gets hotter, blue flames issue from the crucibles, indicating that the sulphur is becoming converted into sulphurous acid. When the flames cease to appear this transformation is completed, and if the crucible is then withdrawn from the furnace it is found full of a green substance. When the heat reaches 700° the blue begins to form. If the heating is now continued, allowing the air still to enter in excess as before, the product takes a violet shade, then red, or rather rose, and becomes ultimately white. This white ultramarine, if mixed with a little charcoal and heated to redness, reproduces red, violet, blue, green, or brown, according to the proportion of charcoal added. By prolonging the heating, and consequently the oxidation, any one of these products derived from the white ultramarine may be made to pass anew through the scale of changes—the brown, for instance, being successively converted into green, blue, rose, and white. If for charcoal we substitute hydrogen, sal-ammoniac, or other reducing agent, the same results are obtained. These facts seem to indicate that the progress of coloration follows that of oxidation. The proof of this is found on the examination of the products obtained at different stages of the heating. Sulphur produces the coloration because if some other member of its group be substituted the ultramarine changes its color. The soda, if it does not directly produce the coloration, is still necessary, since if any other substance is substituted the coloration of the product is hindered. Finally, ultramarine is not a unique compound; there are a whole series of ultramarines, some colored (sulphur, selenium, and tellurium ultramarines), others colorless (potassic, calcic, and lithic ultramarines), and the study of these bodies may possibly throw a new light upon the chemical composition of the pigment.

CHEMICAL PHENOMENA PRODUCED BY ELECTRICITY.

By M. BERTHELOT.

OZONE is formed equally under the influence of both electricities, the oxygen in each tube only being in contact with the internal armature. The proportions are very variable but as a rule the positive electricity produces in the majority of cases the more ozone. In none of the experiments made with the Holtz machine has the author observed the smallest trace of nitrogen compounds produced from mixtures of oxygen and nitrogen, whether moist or dry. With the effluve of Ruhmkorff's apparatus traces have been observed, but only at the highest tensions. Acetylen, on the other hand, is produced in notable quantity in the vapors of organic compounds inclosed along with nitrogen in tubes containing a metallic armature, influenced by the discharges of the Holtz machine. The absorption of nitrogen by organic compounds is effected equally by both electricities, and at the weakest as well as at the strongest tensions, though the time required in the former case is longer. Along with the nitrogenous compounds there is formed not a trace of ammonia, nitric or nitrous acid, or hydrocyanic acid.

DETERMINATION OF TELLURIUM.

By M. L. KASTNER.

THE tellurium precipitated by sugar is collected on a small filter and washed. It is then transformed into tellurous acid by moistening with a mixture of 2 vols. nitric acid, 1 vol. water, and 3 drops of sulphuric acid per 10 c.c. of mixture. The tellurous acid in acid solution is evaporated to dryness in a porcelain capsule and weighed.—*Zeit. für Anal. Chemie.*

[NATURE.]

CHEMICAL NOTES.

Mineral Oil in a Lava of Mount Etna.—In the basaltic zone which reaches from the foot of Mount Etna, in a south-south-easterly direction, near the village of Paterno, there is a prehistoric doleritic lava containing olivine, which surrounds the clay deposits of a mud volcano and which has been examined by Sig. Orazio Silvestri. Under the microscope the lava shows an augitic principal mass with a quantity of olivine and many white transparent crystals of labradorite. The lava contains numerous round or irregular cavities, which are coated with arragonite and which are filled with mineral oil. This oil, of which there is about 1 per cent. by weight in the whole mass, was taken from one of the cavities at 24° C. At about 17° C it begins to solidify and is of a yellowish green tint by transmitted light, while by reflected light it is opalescent and light green. Chemical analysis of the liquid proved it to contain:

Liquid hydrocarbons (boiling point 79°·28).	17·97 per cent.
Hydrocarbons solidifying under 0° (b. p. 280°–400°)	31·95 " "
Paraffin, melting point 52°–57°	42·79 " "
Asphalt (leaving 12 per cent. of ashes)	2·90 " "
Sulphur	4·32 " "
	99·93

Formation of certain Bodies at Temperatures above that of their Decomposition.—MM. Troost and Hautefeuille have lately demonstrated that under certain circumstances it is incorrect to suppose that bodies undergoing decomposition or rather dissociation at a low temperature may not exist as definite compounds at higher temperatures. Their arguments are founded on the decomposition of silicon sesquichloride (Si_2Cl_6) at 800°, which may be represented as—

$$2Si_2Cl_6 = 3SiCl_4 + 8i;$$

if, however, the reaction be carried on at a temperature above 1200° the following change takes place—

$$3SiCl_4 + Si \quad 2Si_2Cl_6.$$

If the tube in which this reaction take place be cooled suddenly, the sesquichloride is found, but if cooled slowly it undergoes gradual decomposition. They also find that although ozone is converted into oxygen at 250°, if a silver tube, inclosed in a porcelain tube, be kept at about 1300°, a deposit of dioxide of silver is produced, due to the formation of ozone. They state that the ozone can be recognized by the usual tests, if the gas be rapidly drawn off and quickly cooled. They have also examined certain similar phenomena in the production of oxide of silver at 1400°.

New Modes of Forming Ethylen Oxide.—In the *Comptes Rendus*, lxxxv., 624, Mr. H. Greene mentions the results of experiments on the action of certain metallic oxides on the bromide, iodide, and chloriodide of ethylene. Oxide of silver has a rapid action on ethylen iodide at a temperature of 150°, forming ethylen oxide; its action on ethylen bromide produces the same result, but requires a higher temperature. Ethylen bromide and chloriodide both act upon sodium oxide at 180°, the latter of the ethylene compounds being the one found most advantageous by the author in preparing ethylen oxide. He has also studied the action of these substances on the oxides of the diatomic metals barium and lead. These oxides do not give ethylen oxide when heated with bromide or chloriodide of ethylene. These experiments show on the one hand the analogy between the silver and sodium oxides, confirmed by the isomorphism of their anhydrous sulphates and chlorides, and on the other their difference from the group of diatomic oxides.

Iodates of Cobalt and Nickel.—Prof. F. W. Clarke describes these salts, which were prepared by dissolving the carbonates in aqueous iodic acid, and allowing the solution to evaporate spontaneously, when salts of the composition, $Co(IO_3)_2.6H_2O$ and $Ni(IO_3)_2.6H_2O$ crystallize out. If the solution of the carbonate of cobalt in iodic acid is evaporated rapidly, then the iodate of Rammelsberg, containing 1½ molecule of water, may be obtained, but not otherwise. The cobalt iodate loses four molecules of water at 100°, but the remaining two molecules cannot be driven off without partial decomposition of the salt. The specific gravities of the two salts are almost identical, the cobalt iodate at 21° being 3·6893, the nickel iodate at 22° being 3·6954. No numbers of the solubilities of the two salts are given by Prof. Clarke, but these, when obtained, will be of some interest.

ARTIFICIAL PRODUCTION OF CORUNDUM, RUBY, AND VARIOUS CRYSTALLINE SILICATES.

By MM. E. FREMY AND FEIL.

THE authors begin by forming a fusible aluminate and heating it to bright redness with a siliceous substance; the alumina is in this case slowly liberated from its saline combination in presence of a flux, and crystallizes. They attribute the crystallization of the alumina to different causes, either to the reduction of this base by the gases of the furnace, or to the formation of a soluble silicate when the alumina is displaced by silica, or to a phenomenon of liquidation, which produces a very fusible silicate and sparingly fusible alumina. The displacement of alumina by silica seems the best method for effecting the crystallization of the former earth. The authors place in a crucible of refractory earth a mixture of equal weights of alumina and red lead, and on calcining at bright redness for a sufficient time they find in the crucible, when cold, two distinct layers; the one is vitreous and consists of lead, the other is crystalline and often presents nodules filled with fine crystals of alumina. In this process the crucible acts by means of the silica which it contains. To avoid the loss of the product the authors generally use a double crucible. Colorless crystals of corundum are produced by the method just described, but the color of the ruby may be obtained by adding from two to three parts of bichromate of potash, and that of the sapphire by using a small quantity of oxide of cobalt mixed with a trace of bichromate of potash. The crystals of ruby thus obtained are generally covered with silicate of lead, from which they have to be freed by prolonged heating in hydrogen and subsequent treatment with acids and alkalies. In certain cases crystals have been found almost pure and presenting all the characters of natural corundum and ruby. By the action of equal weights of silica and fluoride of aluminium kept at a red heat for several hours the authors obtain a silicate of alumina, agreeing in its composition and properties with dysthene, and on substituting boric acid for silica they produce a crystalline borate of alumina.

DETERMINATION OF OILS.

PROF. R. H. THURSTON, in a recent lecture before the Master Car Builders in this city, described an interesting method of determining the quality and kind of any oil. He said: "Procure a perfectly clean basin and pour into it perfectly clean water. Drop on the surface a drop of the oil which it is desired to analyze. The oil will spread over the surface of the water, but owing to its tenuity and inability to cover all the surface, will break up into a regular lace-like pattern, spaces of clear water intervening between the lines of oil. The same oil will present the same peculiar lace work at each trial. Different oils have different patterns of lace work, by which they may be at once recognized. To secure a permanent pattern of any oil, by which to compare experiments, the following method is useful: Place a piece of blotting paper lightly on the floating lace work. It will immediately absorb the oil. Then place the same paper on a surface of ink. The parts covered by the oil will be protected from the inks, while the other portions will absorb the inks. A perfect pattern of the peculiar lace work will thus be secured for future use."

PHOTOGRAPHY IN COLORS.

JOSEPH ALBERT, photographer to the court at Vienna, has finally succeeded in inventing photography to render the natural colors in the picture by a photographic steam press of his own construction without the aid of a pencil. An expert painter could hardly give the colors of the object more faithfully in living reality and with the distinctness to the nicest shades than in these colored photographs by the Albert press. The secret of the invention consists in the analysis of the white light into the three colors, yellow, blue, and red, and in the recovery of the three colors ready for the press. On a plate, chemically prepared so as to receive but the yellow parts of the light, and the tones of the colors of the object to be reflected, the first photograph is taken, when a negative of that plate is at once put under the press, whose cylinder is dubbed over with yellow paint. None but the tones of the yellow colors are now seen in the impression. After that the object is photographed on the plate made to reflect but the blue colors. This plate now under the press reflects a blue impression, the cylinder being dubbed over with blue paint. In the same manner he receives but the tones of the red colors by means of a third plate. Printing the individual pictures of the yellow, blue, and red over each other, a picture is produced true to nature, the colors intermixing by having been printed over each other. The idea, long entertained and prosecuted by Albert, to photograph colors, may no longer be considered as not feasible. It is very hard at the present time to foretell how great a revolution this new invention will produce in the many departments of art.

COLLODIO-CHLORIDE PAPER.

SOME portraits upon this paper which we have seen recently, and which excited not only our admiration but that of many photographers, have induced us to lay before the readers of this paper the process by which collodio-chloride paper is prepared at the present day. In making this paper a substratum is necessary upon which the sensitive film can be spread; this substratum is made in the manner following:

A solution of good white gelatine is first of all prepared; the white of twenty eggs is next beaten to a froth, the same being cleared by standing. Equal quantities of the two solutions are then intimately mixed together, the temperature being slightly warmed. To this solution is added some baryta white, which is gradually stirred in until the mixture has assumed the consistence of a syrup. Some finely-powdered asbestos is next added (about one-sixth of the baryta employed), and finally to the whole is added a solution of one and a half grammes of citric acid in fifteen grammes of water.

This mixture is applied as uniformly as possible by the aid of a broad camel's hair brush to ordinary unprepared Saxe or Rive paper. A badger hair brush permits of the coating being subsequently equalized. The sheet when dry is coated a second time, allowed to dry once more, and then well pressed. Every sheet is next brushed over with a stiff brush until a high and uniform gloss has been obtained, the surface being afterward rolled to make it yet more smooth.

Prepared in this manner, the sheets of paper have a beautiful white polish, such as no albumenized paper can boast. The pictures have an elegant enameled appearance, and leave nothing to be desired on the score of softness and delicacy.

The collodio-chloride employed for the paper differs very materially from that usually used for glass positives. The only important point is that in this case two collodions are required of different sensitiveness, which, by being mixed together, exhibit that vigor and softness combined which are the characteristics of collodio-chloride prints.

COLLODION NO. 1.

Normal collodion (2 to 3 per cent. of pyroxyline)	600 grammes.
Chloride of magnesium	45 "

To this chlorized collodion is added the undermentioned solution:

Nitrate of silver	11 grammes.
Water	16 "
Alcohol	16 "

The nitrate crystals are, in the first place, dissolved in the water, and then the alcohol is added, drop by drop, the liquid being well shaken the while; afterward the latter is gradually added to chloride of magnesium collodion.

The turbid milky collodion thus produced is next treated with the following solution, when it stands ready for use, namely:

Citric acid	4 grammes.
Water	8 "
Alcohol	8 "

This collodion is capable of being kept for weeks in good condition.

COLLODION NO. 2.

Normal collodion	625 grammes.
Chloride of magnesium	3·75 "

To this is added a solution made up of—

Nitrate of silver	16 grammes.
Water	16 "
Alcohol	16 "

and afterward a citric acid solution composed as above.

Both collodions are permitted to stand a few days in the dark; they are then decanted from any precipitate that may have formed, and mixed together; they are then in a condition proper for use.

The application of the collodion to the enameled paper is done in the simplest way by pinning a sheet upon a flat board, and treating it as if it were a glass plate.

It is a very good plan to allow the collodion to remain unmixed, the first to be applied as a substratum for the second. The action of the collodion is just the same.

The prints are produced in a printing-frame in the same way as those on albumenized paper; care must be taken, however, for it is necessary to bear in mind that the collodio-chloride paper is stiffer and more liable to break up. The print must be examined with caution; it must be slowly and gently raised, and not lifted like a bit of ordinary silver paper. As in printing upon albumenized paper, it is necessary to let the printing go rather deeper than it is to appear upon the finished print. At times it happens that the pictures lack depth, and in this case the printing should be conducted with a pad impregnated with ammonia; in other words, you place in the printing-frame, between the back of the picture and the padding, a flat kind of *sachet*, filled with bicarbonate of ammonia.

Before toning and fixing, it is well to trim the pictures, so as to be as economical as possible with the gold bath. For toning purposes two solutions are prepared:

1.—Sulpho-cyanide of ammonium	40 grammes.
Hyposulphite of soda	4 "
Distilled water	1½ liter.
2.—Chloride of gold	2 grammes.
Distilled water	1½ liter.

When using the above, equal volumes of both these solutions are taken and mixed together. As they keep very well, both of them—the latter being, indeed, very stable—it is in one's power to make up a toning bath very speedily. An impoverished bath is put in order by the addition of a few drops of solution No. 2. As soon as the prints have attained the right tone, which must not be of too blue a tint, they are washed in ordinary water, and fixed in the undermentioned solution:

Hyposulphite of soda	40 grammes.
Distilled water	1 liter.

For fixing, a period of from eight to ten minutes is necessary. In washing, a good deal of care is necessary. As I have already said, the paper is liable to crack and break, and for this reason the print must not be allowed to dry in a rolled-up condition. It is the best plan to mount the pictures while still moist.

By passing through a powerful rolling-press, the pictures at once obtain their full beauty. When retouched, they are coated with a varnish made up as follows:

Benzole	500 grammes.
India-rubber	7 "
Mastic	15 "
Canada balsam	4 "

The India-rubber is, in the first place, cut into small pieces and dissolved in a portion of the benzole; in the rest of the liquid is dissolved the mastic, and then the Canada balsam is added, and the two solutions mixed together. This varnish is poured upon the retouched picture, and the appearance of the latter is thereby greatly enhanced.—*Photographische Wochenblatt.*

INSTANTANEOUS PICTURES.

A SHORT focus lens, giving good definition with the largest diaphragm, is well adapted for stereo views; while for larger work, as 8x10 plates, Dallmeyer's Rapid Rectilinear answers admirably. The lenses should invariably be used with full openings, to secure the passage of the greatest amount of light in a comparatively very short time. To better regulate the duration of exposure, a self-acting shutter is desirable. This is easily made out of wood or cardboard, and every photo of average ingenuity will be able to devise some practical contrivance for himself. The time of exposure, of course, varies, for moving objects, with the distance, the velocity of motion, etc., but, as a general thing, from $\frac{1}{15}$ to $\frac{1}{5}$ of a second will give satisfaction. That a bright, clear day is essential, and the hours from 10 A. M. to 2 P. M. should be chosen, every photo will understand. Less generally known, however, is, perhaps, the fact that some fleecy clouds in the sky opposite the camera, as also a gentle western breeze, increase the chances for success materially.

Too great care cannot be used in preparing the plates. They should be absolutely clean on both sides and freshly albumenized, as, owing to the rapid action of the powerful developer, stains and streaks will frequently arise from the albumen substratum being decomposed.

The nitrate bath contains 40 grs. of silver to the ounce, and is slightly acid with C. P. nitric. Iodizing is done by immersing a large collodionized plate in it for a night. To saturate the bath with silver carbonate and then reacidifying it is of advantage, as far as it prevents pin-holes and keeps the shadows clear, but on the sensitiveness of the plates it does not seem to have any effect.

A very sensitive collodion, and one which answers also well for landscape and studio work, is made after the following formula:

Alwood's alcohol (95°)	½ oz.
Sulphuric ether (0·72)	½ oz.
Anthony's climax cotton	6 grs.
Ammon. iod	2½ grs.
Cadm. iod	2½ grs.
Cadm. brom	4 grs.

Dissolve the iodizers in the alcohol, then add the cotton, and finally the ether. Shake until clear; no precipitate should form. The collodion should be of a slightly yellowish color to give the best results, and should therefore be mixed at least two months before use. If this precaution be not taken, crape-markings may result from the large amount of cadmium.

The developer consists of

Double sulphate of iron and ammonia	35 grs.
Sulphate of copper	12 grs.
Acid acetic glacial	15–25 min.
Ammonia conc.	1 min.
Alcohol	20 min.
Water	1 oz.

Immediately before application a few drops of a strong solution of nitrate of lead or acetate of lead in distilled water should be added.

As an instantaneous plate, if successfully taken, is something worth keeping for a longer time than is usual with other negatives, potassium cyanide should be used for fixing; for, if hypo be taken and the plate not be washed profusely, traces of the salt will be left in the film, and the latter will in course of time begin to crack and split, as a number of negatives just before me bear testimony.

Intensification, if necessary, is done in the usual way. I prefer doing it after fixing, and use pyro and silver, followed by a weak iodine solution. This latter gives the negative a nice brown, non-actinic color, which produces brilliant prints.

A salient point to be observed in all manipulations is the temperature of the various solutions. It should be about 60° all the year round for bath and collodion, but the developer, if the plate has been chilled during an outdoor exposure in cold weather, should be gently warmed in order to bring out detail.—TORPEDO, *in the St. Louis Practical Photographer.*

HINTS TO FERROTYPISTS.

By J. R. APPLEGATE.

WE have been using the same bath solution, or a portion of it, for the last six years. We never boil down a bath or solution, but renew it occasionally; then it works the same as new, or better. When we see any signs of about to give out, such as weak impressions, sandy appearance on the plate, requiring longer time to sit, or flat picture, then we add the same amount of water that we have bath solution, then filter and throw in enough silver to make the bath 25 to 30 grains strong test, filter again, and it is ready for use. We never use anything but silver and hydrant water, and never have a bath that shows any signs of fog. We find a solution of 25 grains works better than one of 40. For ferrotypes we often use as strong a bath as 30 grains, but never stronger. By this means we are not troubled with defacing the picture, which is often the case by using the softest brush in coloring. When we use a bath of 40 grains strong, we always use larger baths and never let the dipper touch the bottom of it, but let it reach within about three inches, leaving plenty of room for any sediment that may get in the bath to settle. By so doing we seldom filter the bath, not oftener on an average than once in two months. We dip sometimes as many as two to three hundred plates a day. This not boiling down bath is a saving in the breakage of evaporating dishes, baths, etc., enough to provide us a good lunch occasionally. We find all makers of collodion work about the same, and the common iron developer we find no fault with. Strong cyanite clears up more brilliant than anything, but be careful in using it, for it may be death to the careless. We find any make of ferrotype varnish good, but slightly warm your plate before pouring it on. There is more money and less trouble in the plate picture business than the photographic business, especially when you don't run down the prices to bottom rock.

ALBERT HENDSCHEL.

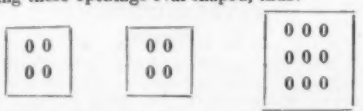
THE *Sonntagsblatt* of the Berner Bund recently gave a Life of Albert Hendschel, the draughtsman of the *Skizzenbuch*, detached leaves from which are to be seen in the window of nearly every print and photograph seller in Europe. It appears that the artist was the son of the publisher of *Hendschel's Telegraph*, the German "Bradshaw," which has been published at Frankfort ever since the commencement of railway traffic in Germany. Ulrich Hendschel, the father, had some renown as a cartographer before he commenced the issue of his serial; he was also a respectable amateur painter, and spent his spare hours, while holding an official position in the Post Office, in painting the portraits of his friends and in figure composition. He taught his children to draw early in life, and as Albert, his second son, showed remarkable natural gifts and passion for art, he resolved, after some slight opposition, that the youth should adopt it as his calling. The final decision in Albert's favor was earned by an extraordinary caricature of a pedantic teacher at the Gymnasium. On leaving the Gymnasium he was sent to the Städel Kunst Institute of Frankfort; and, after passing through all the classes, was taken by Prof. Becker as a special and favored pupil into his *atelier*. In the family circle at his master's house, which was a beloved resort of the then ambassador of the Prussian Bundestag, Herr Bismarck, the youth became acquainted with the future Chancellor. One day, as the great statesman and Prof. Becker were turning over the series of Hauff's Lichtenstein drawings, which young Hendschel had presented to his master, Bismarck said to Becker, "If you do not take pains to make this lad a really able painter, you will some day or other have to reckon with me." There was no need, indeed, of the statesman's warning. Becker had a wonderful gift for detecting the specific bent and capacity of his scholars, and always knew how to direct them along the particular path for which they were predetermined by the character of their gifts. He never sought to undo nature, or to force his own style and inclinations upon those who were marked out for a distinct line of their own. Noticing his almost photographic gift for what he called "taking notes," Becker encouraged his pupil to keep his sketch-book always in his pocket, and to use it on every occasion on which he was fascinated by any group, figure, or attitude. It was his rule that the thing which specially arrests the artist's attention is the very thing which he ought to draw. Hence the streets became Hendschel's studio. He had the power of taking all the details into his memory at the instant of putting his sketch on the paper, and when he had worked up the drawing of a minute in the quiet of his own room, it was hard to believe that the subject had not stood before him for hours as a model. For more than twenty years Albert Hendschel traveled from place to place, "noting." It was his rule never to pass a day without a sketch, whether ill or well, at home or abroad, as his motto shows on the cover of each part of his *Skizzenbuch*—"Kein Tag ohne Linie." When the last page of a sketch-book was filled, "it went into the cupboard," he says, "and lay there in quiet with all the others." The publication of his sketches was due to a happy accident. The photographer Herr Huth was the landlord of Hendschel's studio, and one day he chanced to say to the artist that he should like to photograph some good pencil-drawings. Hendschel carelessly handed him one of his pile of sketch-books. The reproduction of some of these sketches made such an impression in artistic and photographic circles that other photographers seduced Hendschel into lending them one of his sketch-books, or an extracted leaf or two. The copies as yet only circulated among friends; but the demand for them became so great, and the artist was finally so teased by flattering photographers, that he determined to restrict the reproduction of his drawings to the art-publisher Prestel. The first publication took place just before Christmas, 1871, and the new *Skizzenbuch* made such an impression upon persons in search of Christmas presents that no less than 10,000 copies of Hendschel's drawings were absorbed during that winter. The issue has taken greater dimensions each succeeding year, not only at the present-giving time, but at all seasons. In 1872 the article and illustrations in the *Gartenlaube* aroused an interest in the artist among Germans—and readers of German in all parts of the world; the photographs were circulated by thousands over land and sea, and reproduced (not always with exact faithfulness) on earthenware, ribbons, tobacco-pipes, paper-knives, and on nearly every article of the small ornamental furniture of modern life.—*Academy.*

INSECTS DESTRUCTIVE TO PHOTOGRAPHS.

DID any one ever notice photographic prints in albums, frames and elsewhere, which were scarred and sometimes ruined by insects? Having lost some valuable proofs in this way, I was induced to watch for the "varmints," and at last caught one in the act.

The damage is done by a little bug or worm, such as is sometimes found on opening an old book. This little marauder is very flat, soft, and tender, of a silver gray color and about one fourth of an inch long. In some localities it attacks photographs, and if unmolested will soon ruin them. The albumen surface is bitten and scaled, first in the deepest shadows, then the lines and furrows are extended all over the whole print. To prevent the ravages of these moths, the print should be secured to the glass (before framing) by a strip of sticking paper around the edge, so as to leave no place for it to enter. Prints kept loose, in portfolios, albums, etc., should be frequently taken out and aired, the portfolios dusted and thoroughly cleaned. The damaged spots may be touched up with a brush and water colors, mixed to suit the shade of the part peeled.

Ferrotype operators who make four, six or eight gems on a plate often get foggy pictures by the diverging rays of light from one lens passing through the opening of the division board opposite the next lens. This can be avoided by making these openings oval shaped, thus:



The broader space at the corners (between the lenses) serve to keep out these rays, and their images are clearer; while the oval shape serves as a guide in focusing the head to fit the matt.—T. C. HARRIS, in *St. Louis Practical Photographer.*

ON ROTARY-LATERAL CURVATURE OF THE SPINE.

By PROFESSOR LEWIS A. SAYRE.

Lecture delivered at Bellevue Hospital, November 26th, 1877. Reported by P. BRYNBERG PORTER, M.D.

GENTLEMEN: Before commencing the subject which I wish to bring specially before you to-day, I will show you the patient upon whom I performed what is known as *brisement forcé*, for anchylosis of the knee joint, just one week ago, and whom I have not seen since. The house surgeon informs me that, except immediately after the operation, it has not been necessary to give him a single dose of opium, on account of any pain, and that there has been no febrile reaction or inflammatory trouble whatever. About three weeks ago I made a little attempt to move the patella, and succeeded in gaining a small amount of motion, but not having the requisite time then to finish the operation, the limb was left undressed; and in consequence of that very slight movement an acute constitutional fever set in, from which the patient did not recover for a fortnight, and which for ten days required very active treatment, and the constant application of ice to the inflamed joint. All this followed from simply neglecting to employ the proper after-treatment, upon which I lay so much stress. In the operation a week ago I used an infinitely greater amount of force; yet because the joint was properly dressed afterward, there has not been, as you see, the slightest constitutional disturbance in consequence.

You will remember that at that time I succeeded, after a good deal of muscular exertion on my own part, in flexing the leg to less than a right angle, and then by working it backward and forward I broke up the adhesions in the most thorough manner and knocked off all the little projecting points which might be a source of irritation or stiffness in the future. Then the appropriate dressing was applied, and upon this dressing, you will remember that I told you in the most emphatic manner, the entire success of the operation depends. A bandage was applied from the very extremity of the limb, great care being taken to place cotton over all projecting points, and especially to put a large sponge or bunch of cotton in the popliteal space, in order to remove pressure from the flexor muscles; adhesive strips were adjusted, by which extension could be made; and a small piece of sponge was placed over the femoral artery in its lower third, the bandage being carried over it with sufficient tightness to make partial compression of the vessel, and thus diminish the blood supply of the joint. This last manœuver is carrying out the idea of the late Dr. David L. Rogers, who ligated the artery for inflammation of the joint; and Dr. Stephen Smith informs me that it was done before him by Dr. Onderdonk, though I have not met with any notice of the fact myself. You must beware of losing the limb by making this compression too great, for if the artery is too much occluded, of course you will have gangrene result. It is important in the after-treatment that constant extension should be kept up, and that the slightest motion should be prevented. In the present instance plaster-of-Paris was used for the latter purpose, and it is the first time that I have employed it in this connection.

The house surgeon having now cut through and removed the plaster casing, we will take off the bandage and look at the joint; in which we desire to get motion, if possible; though we may not succeed in this. There is fortunately no heat about the knee, and, strange to say, no ecchymosis from extravasation of blood, which is so common after such rough handling as this limb has received. I am now able to make slight movement in the joint, and the patient says that it does not give him the slightest pain. This is quite exceptional, for very often it is necessary to give chloroform before making any motion whatever. I have obtained sufficient movement to prevent adhesion from forming, and each succeeding day it will be found that a little more motion has been gained, until at last the patient will be provided with an instrument with a key, by which he can make the motion himself. In the meanwhile the sponge may now be left off of the artery, and friction and shampooing and electricity may be used about the joint.

Having two or three very interesting cases of rotary-lateral curvature to show you to-day, I should like to make a few remarks on that subject. This affection is a vast deal more frequent than most persons would suppose. Formerly I used to have an idea that it was pretty nearly confined to women and young girls growing up; but of late I have been quite surprised to find such a large number of men afflicted with it. Until the last two years, I always disliked very much to have anything to do with such cases, because I felt that I could really do nothing for them. In Pott's disease I had some success among the rich, though the treatment was not very satisfactory, with Taylor's splint; and among the poor, who could not afford to buy the apparatus, I got along a great deal better with the plaster-of-Paris "turtle shell" applied to the back. But with lateral curvatures I could not do anything at all, and I used to send them all to anybody who said he could cure them. I liked Dr. Banning's method the best, and he used to get most of them; but in the end they all came back again without having received any benefit, and some of them worse than before. You see here half a cart load of old iron, steel and brass, which is really a part of the various appliances which patients have been wearing when they have consulted me for treatment. Mr. Broadhurst's apparatus, which I now show you, for screw and lever power excels any that I have ever seen; but the trouble with it is that after the screw is turned to a certain point it only does injury, instead of good. The torture resulting from such instruments is almost indescribable, and the agony that I have seen patients endure while wearing them has been most affecting. Yet a young girl with a large fortune, a pretty face and a crooked back will suffer anything and do anything in the world if she thinks she can only be made straight by it.

But, owing to recent progress in this department of orthopedic surgery, I am glad to say that we are now able to discard them all, and Dr. Judson, of this city, has given us a beautiful demonstration, which shows why it is that we can improve upon the old methods of treatment. The grandchild of one of the first surgeons in England, who had lateral curvature, and was also supposed to have hip-joint disease, for a long period wore this elaborate back and leg splint which I here show you, and which weighs no less than forty-two pounds. At last the agony of the child became so great that he could not bear the instrument any longer, and during my recent visit to England I was requested to see him. On making a careful examination I found that there was no hip-joint disease whatever, but that the leg on the affected side was an inch and a quarter shorter than the other, in consequence of diastasis of the hip, which had occurred in early childhood, and which is, as you know, equivalent to fracture of the thigh. The child had gotten well with simply a shortened limb; but, owing to this, the back had become temporarily distorted, a primary and secondary curve of the spine resulting from his efforts to keep his equilibrium. An inch and a half was added to the sole and heel of the shoe worn on the shortened limb, and when this was put on it was found that the back became perfectly straight, and this instrument was, in consequence, presented to me as a trophy of correct diagnosis. This case illustrates very forcibly the paramount importance of always getting at the cause of a curvature.

I now exhibit to you Dr. Judson's very ingenious contrivance for showing the philosophy and mode of production of lateral curvature. It is, as you observe, simply a spinal column with a flexible steel rod running through it and the several vertebræ attached to the framework, in which it rests by means of elastic ends. When pressure is made upon the top of the column, it will be observed that rotation of the vertebræ is always produced, and that there are always two curves, a primary and a secondary (or, it may be, a number of primary and secondary curves), resulting. So long as the column is compressed, you can put on all the instruments in the world, and the curves will still exist, and until it can be extended, it is utterly impossible to straighten it. You may even crush in the ribs with the force applied; but no power on earth will make the spine straight until it is loosened at one end or the other. For this admirable demonstration, as I said, the profession is indebted to Dr. Judson.

The first case that I show you to-day is that of a young lad, who first came to me three days ago, and who even in that short time has become much less crooked than he was then. Suspension by the head and the hands was first practiced by Dr. Benjamin Lee, of Philadelphia, in following out the idea of the late Dr. Mitchell, who recommended suspension by the hands alone, but never brought the matter prominently before the profession. The first time that I suspended this young man, the latissimus dorsi muscle stood out so prominently that I thought I should have to make a subcutaneous section of it, but I now find that this will not be at all necessary During the three days he has been practicing self-suspension by means of the tripod and suspensory apparatus which I have had occasion to show the class so frequently, and he is already greatly improved. Having taken a measurement of the patient's height standing, we now proceed to suspend him equally by the head and axilla, in order to put on the plaster jacket. Before this is applied, the patient should always procure a skin fitting shirt, which should be knit to order, after careful measurement. Before putting on the plaster, a folded towel, which I am in the habit of calling a "dinner-pad," should be placed along the anterior part of the chest and abdomen, and we are then ready to commence. The bandage, which, as you know, is made of crinoline, into which powdered plaster has been thoroughly rubbed, and is to be soaked through with water when it is to be used, should be snugly wound around the trunk without being at all tight; and as the house surgeon is making the successive turns, I follow with my hand, rubbing the folds well into all the irregularities of the surface. The latter is a very important part of the proper application of the plaster dressing, and should never be neglected. It also prevents air from remaining between the folds of the roller.

After one or two thicknesses of the bandage have been applied, narrow tins, about a foot in length, may be laid along the thorax, as they help to support the dressing, without adding materially to its weight. The jacket being all complete now, I proceed to make use of a device for causing the plaster to set quickly, which I obtained from an Irish lady during the last summer, and that is the application of a heated iron, and for this purpose I have had constructed a little roller, which is very handy. It also adds a hardness, finish, and polish to the exterior dressing which it would not otherwise have. Before the plaster gets thoroughly hardened (after laying the patient down), your assistant should hold the top of the shirt firmly while you draw out the "dinner-pad," and with your hands you should then press upon the casing, just in front of the anterior spinous process of the ilium, on both sides, so as to flatten it out a little and remove pressure over the bony prominences. If the dressing seems a little weak at any point, it is very easy to strengthen it by wetting the hands and rubbing on some more plaster; and if the jacket extends too high up under the axilla, or is found to be so long as to cause discomfort when the patient sits, it should be cut a little at these points. It is in such careful attention to little details that the success of the treatment in a large measure depends. The plaster being sufficiently hard, the patient may stand up again, when we find that he has now gained, by actual measurement, one inch and some eighths by this single application of the jacket. It is probable that, as time goes on, he may unfold at least half an inch further.

The second patient is an adult man who ought to have been fully six feet high, but who is, you will observe, very much less than that. As he suspends himself by his head, and raises himself by grasping the rope with his hands above it, you will notice that the back straightens a good deal; but this is a very bad case, and in such it takes several months to get the ribs into the right position, and sometimes they never yield. Whatever you can gain by suspension, however, you can retain by means of the plaster. When the patient is not suspended you will observe that there is in his side a very deep depression, and when I place my hand in it it is pressed upon very forcibly by the distorted ribs. I regret to say that the iron cross-piece of our tripod, which was not constructed of good material, has given way, and in consequence we will not be able to apply the plaster dressing to this patient at present.

In conclusion, I will make a few remarks on the after-treatment. Each patient should be provided with an apparatus for practicing self-suspension. When at home, it can be attached to the wall or ceiling by means of a strong screw, and when the person is traveling a folding tripod should be carried along. Every night and morning the patient should suspend himself or herself three times, and during each suspension should make three deep and full inspirations. It was apprehended by some that respiration would be interfered with by the plaster jacket; but in every single case that has been under my care the power of respiration has been markedly increased, as actually demonstrated by the spirometer. This increase is usually from sixteen to twenty-two cubic inches. The color of these patients is usually very bad before treatment, owing to the impeded circulation, but at once changes when they have been suspended and the plaster applied. There was one young lady I remember in particular, who was sent to me by Dr. Mary Putnam Jacobi, and who had always previously been exceedingly pale, but whose cheeks became as rosy as any you could wish to see in the short space of twenty-four hours. In the course of a few days after jacket has been applied, it will be found to have become too loose, and it should then be cut down and tightened, or else an entirely new one applied. It may then be worn from one to four weeks, as the case may be, and somewhat later it may be cut down the front and made to lace up like a corset. Still later in the treatment, when it is no longer necessary to wear the plaster jacket, an appropriately made corset may be used, with great benefit, in its place.

The old notion of curing spinal curvature by lifting the axillæ is an absurd one, for the axillæ have really nothing to do with the spine; but it is a very different matter when the patient suspends himself by the hands placed above the head.

In that case, you in reality elevate the ribs by means of the serrati muscles; and if you can fasten the thorax while thus stretched out to its fullest extent, and then continue to maintain it in that position, you have gained a very great deal, as must be evident to the dullest comprehension. This the application of the plaster jacket enables us to do, and in the most successful manner.—*Med. and Surg. Reporter.*

CHANCRE OF THE LIP—WAS IT COMMUNICATED BY A DENTIST'S INSTRUMENTS?

By C. W. DULLES, M.D., of Philadelphia.

SOME time since Dr. F. F. Maury gave me the opportunity of examining a patient under his care, with the following interesting and unusual history: A. B., a female, aged twenty-six, is a thoroughly respectable housemaid, modest in her bearing, and her character vouched for by her employer, a physician, in whose family she has been for years. She says she has never had any serious illness, and her appearance is strongly corroborative of her statement. Although aware that she has now a grave disease, she does not know its specific nature.

In the month of September, when in perfect health, she suffered with a severe toothache, for the relief of which she applied to a dentist. He put some cotton, bearing an anodyne, into a cavity in one of her teeth, and advised her to have the nerve extracted and the tooth filled. A week later she returned, and he made an application to destroy the nerve. Still a week later he completed the operation, and recommended her to have all her teeth cleaned. To this she consented, and he did it.

At this time, two weeks from her first going to him, the angles of her mouth were much irritated by stretching, and she had observed a small sore near the middle of her lower lip. This, the dentist said, was only a blister, and advised the application of alum to it, which she carried out. However, the effect seemed evil, and the sore developed in about ten days into an angry, indurated ulcer half an inch long and of a somewhat less width, with a yellowish deposit, and an accompanying enlargement of a left submaxillary lymphatic gland. The ulcer and the bubo were both, she says, excessively painful.

Her condition now attracted the attention of the physician in whose family she was serving, who diagnosed a chancre, applied locally an ointment containing the nitrate of mercury, and gave her internally iodide of potassium and iodide of mercury, combined with opium.

The disease then passed on, with malaise and fever, to a general papular eruption, and the woman came, about five weeks after first going to the dentist alluded to, under Dr. Maury's care. She was, at the time of my first examination, ptyalized; on her lower lip was an enormous chancre, surmounted by an ugly excavated ulcer, an inch and a half long by about half an inch wide, with angry-looking, indurated and everted edges, and covered with a nasty yellowish deposit. Below the angle of the left lower jaw was a large and painful bubo. She had a general but not profuse papular syphiloderm. Many of the papules were developed in her palms and soles. On inquiry and examination there appeared to be no other syphilitic manifestations.

Under treatment, the ulcer was, after two weeks, reduced one-half, but there was appearing a very painful pustular syphiloderm. This began upon her shins and calves, and came afterward, though less severely, on her arms and face. Two weeks later she had sore throat. The chancre was healing nicely. Later, this went on quite well, leaving but little loss of substance, and the bubo subsided almost entirely. The pustules, however, were very troublesome. There were many of them, of various sizes and of different grades of ulceration, presenting the features of so-called syphilitic impetigo ecthyma and rupia. Iritis seeming to threaten, instillations of atropia were used with success.

Without going further into the history, we have, then, a case of syphilis whose initial lesion was a chancre upon the lip. The important question is, How was the chancre contracted? The answer to this question involves so many delicate considerations that it may not be wise to express here a positive opinion in regard to it; but to entertain one, these points should be borne in mind: A woman of unimpeached reputation subjects herself to the manipulations about the mouth inseparable from a dentist's operations; about two weeks later there appears on her lip a lesion, the development of which is that of a typical chancre, and which is followed by other unmistakable manifestations of syphilis.

Bearing these facts in mind, whatever may be one's opinion in regard to the source of the syphilitic contagion and its manner of communication, the history of this case may well serve as a warning to all dentists, as well as to the medical profession. It will have a special weight if considered in connection with the cases of inoculation from the virus of mucous patches in the mouth, recently investigated by Dr. Maury and the writer, and reported in the *American Journal of the Medical Sciences* for January, 1878, in an article entitled "Tattooing as a Means of Communicating Syphilis."

A prominent member of the dental profession in this city recently assured me he was constantly on his guard against the danger of conveying disease from one of his patients to another, keeping a special lookout for suspicious lesions. He has, he says, detected syphilitic lesions, and might, without this precaution, have inoculated them upon others. Such a course deserves to be followed by all; and perhaps it might not be amiss—if not already done—for the dental colleges to teach their pupils the diagnosis of syphilitic lesions in and about the oral cavity, impressing upon them the danger of inoculation and the means of avoiding it.—*Med. and Surg. Reporter.*

REMARKABLE KNEE JOINT SURGERY.

IN a case of transverse fracture of the patella, Mr. Lister cut down on the fragments, opening the knee joint, cleansed the surfaces of the fragments, and, having established an independent drain of horsehair for the knee joint, drilled the two portions of the patella and tied the fragments together with silver wire, and then closed the wound, which was also drained with horsehair.

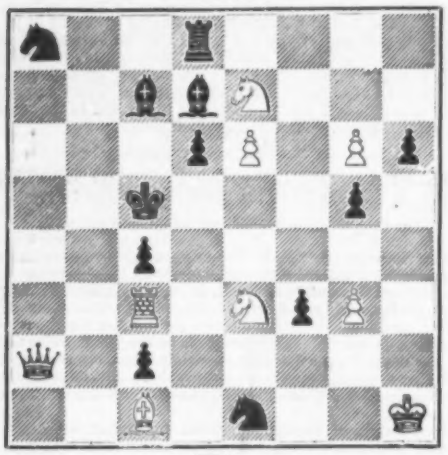
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 54. BY H. F. L. MEYER.

First Prize.—*Clipper* Tournament.

Black.



White.

White to play and mate in five moves.

HERR MEYER AND THE CLIPPER TOURNEY OF 1876.

White to play and mate in 3 moves.

HERR MEYER, of Hanover.

LITTLE desire as we have for discussions of a personal character, we find that it is a matter of general interest to state that we are in receipt of a most positive denial on the part of Mr. Meyer that he had anything to do with the tampering with the problems of other composers or the use of his name, and brands the act, as well as that of their publication, as contemptible piracy.

Nothing is so damaging to "the respectability" of chess and insulting to a composer as to find his works not only plagiarized, but appropriated, by what a distinguished critic has designated as the inactive piece device, which consists in merely adding a useless piece or two, and then claiming the problem.

We do not clearly see the why or the wherefore, but it is claimed that the new British Problem Association aimed at correcting this growing evil by disfranchising all who are not British-born subjects.

Mr. Meyer is not only a skillful and versatile composer of problems, as our selections will show, but is the most prolific of modern chess writers, and is also the inventor of a clever universal notation, by a skillful manipulation of which a composer can clothe his solution in some of the strongest words known to the English language.

It is a curious absurdity that the *Lebanon Herald* problem should have been ascribed to Mr. Meyer, on account of the initials of the composer forming the German query "was?" and that the Centennial (S. L. in German Es-el) should be rendered by the *Derbyshire Gazette* into "her mare."

The series of *Clipper* Tournaments, of which we have given a detailed record, finally culminated in the grand tournament of 1876, wherein $75, $40, and $10 were offered for the best sets of four problems in from two to eight moves.

In order to prevent the competition from being too excessive it was stipulated that one of the problems should be a mongrel, "Black to mate, standing in check," etc., which had the anticipated effect, and but one competitor entered from this side and four from Germany. Herr Meyer gallantly carried off the first prize with one of his earlier four-move problems, most skillfully built up into a five. As the other competing sets proved faulty, the second prize was won by A. Z. Huggins, and a third prize tendered to Mr. Berger, but declined on account of alleged unfairness, which has left the present result of the award wrapped in the mists of uncertainty.

No gentleman ever has or ever would question or dispute an umpire's award, yet we cannot close without merely remarking that we would like to be the umpire in some of these tournaments where composers enter problems that have been previously published.

As there are doubtless many British-born subjects residing in the States for whom the new English Problem Association may possess interest, we mention that the election of permanent officials has taken place with the following result:

Hon. Treasurer.—Mr. W. T. Pierce.

Hon. Secretary.—Mr. J. Paul Taylor.

Umpire.—Mr. Duffy.

Messrs. Andrews and Abbott were appointed judges, which latter offices have hitherto not been required in problem tournaments, as the question of nationality has never before been raised.

In justice to all, the committee are bound to make a most searching examination, and should require competitors to forward their family registers and marriage certificates of at least three generations. Mr Bull, of the Detroit *Free Press*, who is a jolly Britisher, takes exception to the programme, doubtless thinking, like ourselves, that it is an insult to such composers as Healy, Campbell, Finlinson, Grimshaw, Contes, Collins, or White, against any one of whom no living composer could be so burdened with conceit as to imagine he could cope with any certainty of success.

NEW YORK VS. PHILADELPHIA, 1857.

GAMES in the match by correspondence between the cities of Philadelphia and New York, begun in February, 1856, and concluded in February, 1857, in a victory for the Philadelphia players.

PHILADELPHIA. WHITE.	NEW YORK. BLACK.
1. P to K 4	1. P to K 4
2. K Kt to B 3	2. Q Kt to B 3
3. P to Q 4	3. Q Kt x P
4. Kt x Kt	4. P x Kt
5. K B to Q B 4	5. Q to K B 3
6. Castles.	6. B to Q B 4
7. P to K 5	7. Q to K B 4
8. P to Q B 3	8. P x P
9. Kt x P	9. Kt to K 2
10. K B to Q 3	10. Q to K 3
11. Kt to K 4	11. B to Q 5
12. Kt to Kt 5	12. Q to Q Kt 3
13. Q to K R 5	13. P to K Kt 3
14. Q to K R 6	14. B x K P
15. K R to K sq	15. Q to K B 3
16. Kt to K B 3	16. P to Q 3
17. B to K Kt 5	17. Q to K 3
18. Kt x B	18. P x Kt
19. Q R to Q B sq	19. K R to K B sq
20. B to Q B 4	20. Q to K B 4
21. B x Kt	21. K x B
22. P to K B 4	22. P to K 5
23. B to Q 3	23. B to K 3
24. B x P	24. Q to Q R 4
25. Q to K R 4 ch	25. K to Q 2
26. K R to Q sq ch	26. K to K sq
27. K to K R sq	27. P to Q B 3
28. R x Q B P	28. Q R to Q sq
29. Q R to Q B sq	29. R x R
30. R x R	30. P to K R 4
31. Q to K B 6	31. B to Q B sq
32. B x Q Kt P	Resigns.

H. F. L. MEYER.

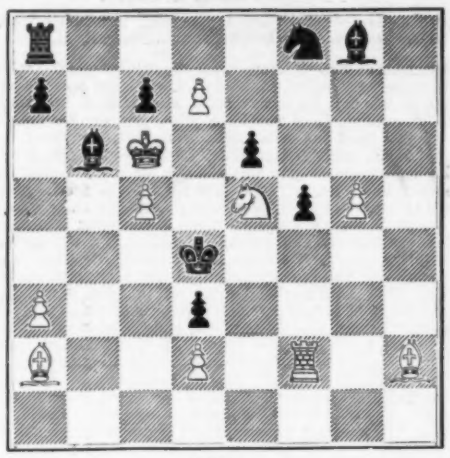
NEW YORK. WHITE.	PHILADELPHIA. BLACK.
1. P to K 4	1. P to Q B 4
2. P to Q 4	2. P x P
3. K Kt to B 3	3. P to K 3
4. Q x P	4. Q Kt to B 3
5. Q to Q sq	5. K B to Q B 4
6. K B to Q 3	6. K Kt to K 2
7. Q Kt to B 3	7. P to Q 4
8. P x P	8. K Kt x P
9. Q Kt to K 4	9. B to Q Kt 3
10. K B to Q Kt 5	10. Castles.
11. K B x Kt	11. P x B
12. Castles.	12. P to K B 4
13. Q Kt to K Kt 3	13. Q to Q B 2
14. P to Q B 4	14. Kt to K B 3
15. Q to Q B 2	15. P to Q B 4
16. P to Q Kt 3	16. B to Q Kt 2
17. K Kt to Kt 5	17. Q to Q B 3
18. P to K B 3	18. B to Q B 2
19. K R to K sq	19. Q R to K sq
20. B to Q Kt 2	20. P to K Kt 3
21. K R to K 2	21. P to K 4
22. Q R to K sq	22. P to K 5
23. P x P	23. K B to B 5
24. K Kt to K R 3	24. B x Kt
25. P x B	25. Kt x P
26. Kt to Kt 5	26. Kt x Kt
27. Q to Q B 3	27. Q x K Kt P ch
28. R x Q	28. R x R ch
29. Q x R	29. Kt to B 6 ch
30. K to B sq	30. Kt x Q
31. R to Q 2	31. P to B 5
32. P x P	32. Kt to K Kt 7
33. R to Q 7	33. R x P ch
34. K to Kt sq	34. B to K 5
35. R to K Kt 7 ch	35. K to B sq
36. R x K R P	36. Kt to K 6
37. R to K R 8 ch	37. K to B 2
38. B to K 5	38. R to K B 8 ch
39. K to K R 2	39. Kt to K B 4
40. K to R 3	40. P to K Kt 4

41. R to Q B 8, and Philadelphia announced mate in six moves.

PROBLEM No. 55. BY H. F. L. MEYER.

First Prize.—*Clipper* Tourney.

Black.



White.

White to play and mate in four moves.

SOLUTIONS TO PROBLEMS.

No. 48.—BY JAMES MASON.

WHITE.	BLACK.
1. Q to Q B 8	1. K x B
2. Q to K Kt 4	2. P to K 5
3. Q to Kt 8 mate	
	1. K elsewhere
2. Q to K R 3 ch	2. K moves
3. Mates.	
	1. P to B 5
2. Q x P ch	2. K to K 6
3. B to K Kt 5 mate.	

No. 49.—BY S. LOYD.

WHITE.	BLACK.
1. K to Q Kt 3	1. Any move
2. Mates accordingly.	

LETTER "L."—BY J. HALL.

WHITE.	BLACK.
1. B to Q B 6	1. K moves
2. R x B	2. Any move
3. Mates.	

ENIGMA No. 12.—BY S. LOYD.

WHITE.	BLACK.
1. R to Q B 8	1. K to Q or Kt 4
2. Kt to K 5	2. K to B 4
3. P to B 4	3. K moves.
4. Kt mates (twenty-four variations).	

ENIGMA No. 13.—BY S. LOYD.

WHITE.	BLACK.
1. K to Q 3	1. R to K 5 ch
2. K x P	2. R checks
3. K x R	3. K or P moves
4. Q mates.	

ENIGMA No. 14.—BY S. LOYD.

WHITE.	BLACK.
1. R to Q 8	1. P to Q 7 (or K to Q 7)
2. B to K R 3	2. P to K 7
3. B to Q 7	3. P x Kt
4. B to B 5 dis. mate (several variations).	

ENIGMA No. 15.—BY JACOB ELSON.

WHITE.	BLACK.
1. Kt to Q B 7	1. Any move
2. Mates accordingly.	

THE following positions are selected from the *Clipper* Tournament of 1876:

ENIGMA No. 21.—BY H. F. L. MEYER.

(From the set that received the First Prize.)

White.—K on Q R sq, Q Q R 5, R Q 6, B Q B 7, Kts K B 2 and K R 7, P Q B 5.

Black.—K K 4, Rs K sq and K R 7, Kts Q Kt 8 and K R 3, Ps Q R 3, Q Kt 2, K 3, K 7, K B 5, K Kt 3 and K R 4.

White to play and mate in three moves.

ENIGMA No. 22.—BY A. Z. HUGGINS.—Second Prize.

White.—K on Q Kt 2, R K R sq, Bs Q Kt sq and Q B 7, Kts Q 7 and K Kt sq, Ps Q R 5, Q 2, K 3 and K 6.

Black.—K Q Kt 5, Ps Q Kt 4, K 2, K 5 and K R 7.

White to play and mate in four moves.

ENIGMA No 23.—BY J. BERGER.—Third Prize.

White.—K on K R sq, Q Q B 7, B K B 4, Kts Q 3 and 8, Ps Q R 3, Q Kt 4, Q B 2, K 2, K B 2, K Kt 3 and K R 6.

Black.—K K 5, R Q R sq, Bs Q R 2 and Q B sq, Kt K 6, Ps Q R 4, Q Kt 2, Q B 6, Q 2, K B 2, K B 3, K R 4 and 6.

White to play and mate in five moves.

PRINCESS CHARLOTTE being one evening present when a game of chess was playing, the sudden and triumphant exclamation of "checkmate" was given. On her inquiring its meaning, she was informed it is when the king is *en prise* by any particular piece, and cannot move without falling into the hands of an enemy.

"That is indeed a bad situation for a king," said the little patriotic stateswoman, "but it can never be the fate of the King of England so long as he conforms to the laws; for then he will meet with protection from his subjects."